Assessing progress towards an ecologically coherent network of Marine Protected Areas in the Northern Ireland inshore region

Alice Cornthwaite, Hugh Wright,

Rebekah Cioffi and Jon Davies

Joint Nature Conservation Committee

January 2018

Assessing progress towards an ecologically coherent network of Marine Protected Areas in the Northern Ireland inshore region

Executive summary

In December 2016, the Department of Agriculture, Environment and Rural Affairs (DAERA) designated four Marine Conservation Zones (MCZs) in the Northern Ireland inshore region to supplement Strangford Lough MCZ designated in 2013. These sites, combined with the addition of the North Channel candidate Special Area of Conservation in early 2017, increased the network of Marine Protected Areas (MPAs) in Northern Ireland to 48 sites, occupying 38% of the inshore region.

In the context of these developments, DAERA asked JNCC to assess the progress of the MPA network in the Northern Ireland inshore region against Northern Ireland's marine conservation policy commitments. This assessment could be used to inform decisions on whether any further designations would be required to complete the Northern Ireland MPA network. Furthermore, if any potential shortfalls were identified, the assessment would determine what ecological gaps in the network could be addressed using current information on the presence and distribution of MPA features.

JNCC assessed the progress of the MPA network in the Northern Ireland inshore region specifically, but also the contribution of Northern Ireland's MPAs to the broader UK MPA network within the two biogeographic regions adjoining Northern Ireland: the Irish Sea region and Minches & Western Scotland region.

DAERA and JNCC agreed the following criteria to assess the MPA network within the Northern Ireland inshore region:

- each MPA feature of conservation interest in Northern Ireland should be represented in the MPA network;
- broad-scale habitat features should be protected (replicated) in at least two MPAs;
- Northern Ireland's Priority Marine Features (PMF) and proposed MCZ (pMCZ) habitat, species and geological/geomorphological features should be replicated in at least two MPAs;
- a minimum of 10% of the known area of each subtidal broad-scale habitat should be protected in MPAs; *and*
- MPAs should be well connected with sites affording protection to the same broad habitat type no further than 80km apart from each other.

Overall, the current suite of MPAs in the Northern Ireland inshore region is very close to delivering an ecologically coherent network in Northern Ireland. The majority of MPA features of conservation interest are already represented and replicated in the MPA network. A small number of features do not meet the benchmarks set by the network criteria but these shortfalls typically only relate to replication or the amount of habitat afforded protection.

All broad-scale habitats, Northern Ireland PMF/pMCZ species and all but one Northern Ireland PMF/pMCZ habitat are represented in MPAs at least once; Native Oyster (*Ostrea edulis)* beds is the only gap in network representativity. Only one out of the 24 broad-scale habitats is not yet replicated in the Northern Ireland MPA network (*Low energy circalittoral rock*) and broad habitat types are well connected across the Northern Ireland inshore region. Shortfalls in the area of habitat afforded protection in the network were found for only four of the 12 subtidal broad-scale habitats assessed: *Moderate energy circalittoral rock*; *Low energy circalittoral*

rock; *Sublittoral coarse sediment*; and *Sublittoral mud*. There are also just six out of 22 PMF/pMCZ habitats and 19 out of 93 PMF/pMCZ species that are not replicated in the network and four pMCZ geological/geomorphological features that are not represented or replicated; these shortfalls could be addressed by further protection of these features.

The MPAs in the Northern Ireland inshore region also make a substantial contribution toward an ecologically coherent network in the wider Irish Sea and Minches & Western Scotland regions. At the regional scale, some gaps remain for the area of broad-scale habitats protected, and the representativity and replication of several PMF/pMCZ habitats and species in the wider UK MPA network. Addressing gaps within the Northern Ireland inshore region would simultaneously help to completely or partially address some of these gaps in the wider UK MPA network.

JNCC evaluated the criteria and suggested methods to further refine this assessment of whether the MPA network is ecologically coherent. For example, site viability and the representativity of biological communities at different seabed depths (particularly within subtidal sediment broad-scale habitats) could be examined to inform and further improve the likelihood of achieving an ecologically coherent network of MPAs. Changing evidence, future MPA designations and the development of MPA management measures will all effect our scientific understanding and therefore achieving an ecologically coherent network of MPAs should be considered as a fluid rather than a static goal.

Contents

Executive summary 2

1. Background 6

2. Criteria for identifying gaps in the MPA network 8
   - 2.1 Assessment criteria 9

3. Assessment scope and input data 11
   - 3.1 Biogeographic regions 11
   - 3.2 Features for consideration 13
   - 3.3 Marine Protected Areas and their protected features 14
   - 3.4 Broad-scale habitat map 16
   - 3.5 Spatial extent of protected features 16
   - 3.6 Limitations of the input data 17

4. Methods 18
   - 4.1 Assessment of the MPA network against network criteria 18
   - 4.2 Reviewing shortfalls to identify gaps 21
   - 4.3 Determining final outcomes 22
   - 4.4 Evidence quality assurance 22

5. Progress of the MPA network in the Northern Ireland inshore region 23
   - 5.1 Broad-scale habitats 23
   - 5.2 Broad-scale habitat representativity and replication 23
   - 5.3 Adequacy of subtidal broad-scale habitat protection 23
   - 5.4 Priority Marine Feature (PMF) and proposed MCZ (pMCZ) habitats and species 26
     - 5.4.1 Representativity of PMF/pMCZ habitats and species 26
     - 5.4.2 Replication of PMF/pMCZ habitats and species 26
   - 5.5 Proposed MCZ (pMCZ) geological and geomorphological features 30
   - 5.6 Connectivity of broad habitats 31

6. Assessment of the wider MPA network at the biogeographic scale 32
   - 6.1 Broad-scale habitats 32
   - 6.2 PMF/pMCZ habitats 33
   - 6.3 PMF/pMCZ species 33

7. Comparison of results for the Northern Ireland inshore region and the wider biogeographic scale 35
   - 7.1 Broad-scale habitats 35
   - 7.2 PMF/pMCZ habitats and species 35

8. Summary of the status of the MPA network in the Northern Ireland inshore region 37

9. Ecological coherence: a moving target 39
   - 9.1 Refining MPA network criteria 39
     - 9.1.1 Refining MPA network criteria by depth 39
     - 9.1.2 Site viability 41
   - 9.2 Changing evidence 41
   - 9.3 Developments to the MPA network 42

Annex A: MPA features for network assessment 43
   - Habitats 43
   - Low/limited mobility species 44
   - Highly mobile species 46
   - Geological/geomorphological features 47

Annex B: Technical account of area calculations for assessing adequacy of subtidal broad-scale habitats 48

Annex C: Detailed results of the assessment at the biogeographic scale and the link to the Northern Ireland inshore region 50

- AC.1 Broad-scale habitats at the biogeographic region scale 50
- AC.2 PMF/pMCZ habitats at the biogeographic region scale 54
- AC.3 Species at the biogeographic region scale 56
- AC.4 Connectivity of MPAs at the biogeographic region scale 58

Annex D: Assessment of the Northern Ireland MPA network split by biogeographic region 60

- AD.1 Broad-scale habitats 60
- AD.2 PMF/pMCZ habitat gaps at the biogeographic region scale 63
- AD.3 Species habitat gaps at the biogeographic region scale 65

Annex E: Supplementary analyses to refine the MPA network criteria 70

- AE.1 Coverage of MPAs by seabed depth 70
- AE.2 Broad-scale habitat protection by depth biozones 72
- AE.3 Site viability 75

1. Background

The UK Government and Devolved Administrations are committed to creating an ecologically coherent network of Marine Protected Areas (MPAs) in UK waters[1]. The UK's MPAs will contribute towards an ecologically coherent network of MPAs in the North-East Atlantic, linking with regional, European and global initiatives such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), the EU Marine Strategy Framework Directive and the Aichi Biodiversity Targets under the Convention on Biological Diversity.

In December 2016, the Department of Agriculture, Environment and Rural Affairs (DAERA) designated four new Marine Conservation Zones (MCZs) in the Northern Ireland inshore region to supplement Strangford Lough MCZ, designated in 2013. These sites, combined with the addition of the North Channel candidate Special Area of Conservation (cSAC) in early 2017, increased the network of MPAs to 48 sites occupying 38% of the Northern Ireland inshore region.

In the context of these developments, DAERA asked JNCC to assess the progress of the MPA network in the Northern Ireland inshore region against Northern Ireland's marine conservation policy commitments. This assessment could be used to inform decisions on whether any further designations would be required to complete the Northern Ireland MPA network. Furthermore, if any potential shortfalls were identified, the assessment would determine what ecological gaps in the network could be addressed using current information on the presence and distribution of MPA features.

JNCC assessed the progress of the MPA network in the Northern Ireland inshore region specifically, but also the contribution of Northern Ireland's MPAs to the broader UK MPA network in the two biogeographic regions adjoining Northern Ireland: the Irish Sea region and Minches & Western Scotland region (based on the Charting Progress 2[2] regional seas).

DAERA requested that the assessment should consider whether (and how) the Northern Ireland inshore network of MPAs could be improved to better protect the habitats and species of conservation importance in Northern Ireland, but also how any improvement could also address any gaps in the UK MPA network at the wider biogeographic scale. The assessment therefore addressed two key questions:

1. What do the existing MPAs in the Northern Ireland inshore region contribute to the protection of priority habitats and species for Northern Ireland and are there ecological gaps in the network that could be practically addressed through further site designation?
2. What do the existing network of MPA in the wider regional biogeographic scale protect and are there ecological gaps that could be practically addressed through further site designation in the Northern Ireland inshore region?

The first question was addressed by identifying what habitat, species and geological/geomorphological features are protected in the Northern Ireland inshore region; combined with an analysis of the extent of subtidal broad-scale habitats protected. The Northern Ireland inshore MPAs were then assessed against an agreed set of criteria that define an ecologically coherent network (see Section 2 for more detail on the principles and criteria for an ecologically coherent network). JNCC and DAERA validated the accuracy of the

[1] Joint Administrations Statement. 2012. UK Contribution to Ecologically Coherent MPA Network in the North East Atlantic. Available at: http://www.scotland.gov.uk/Resource/0041/00411304.pdf

[2] Charting Progress 2. Published by the Department for Environment, Food and Rural Affairs on behalf of the UK Marine Monitoring and Assessment Strategy community. Available online at: http://chartingprogress.defra.gov.uk/

results to draw conclusions on whether the overall network is ecologically coherent and to identify any remaining gaps.

The second question was addressed using a similar three-step process: cataloguing the protected features of the wider MPA network; assessing the results against an agreed set of criteria; and validating results to determine any gaps at the biogeographic scale. These results were then interpreted from a Northern Ireland perspective, indicating any gaps at the wider biogeographic scale that the Northern Ireland could potentially help to address.

This present report sets out the methodology, results and overall findings of the assessment. The report is structured in line with the two spatial scales of assessment followed by an assessment of the potential to address any gaps at both the Northern Ireland inshore region and wider biogeographic scales simultaneously (as shown in Figure 1).

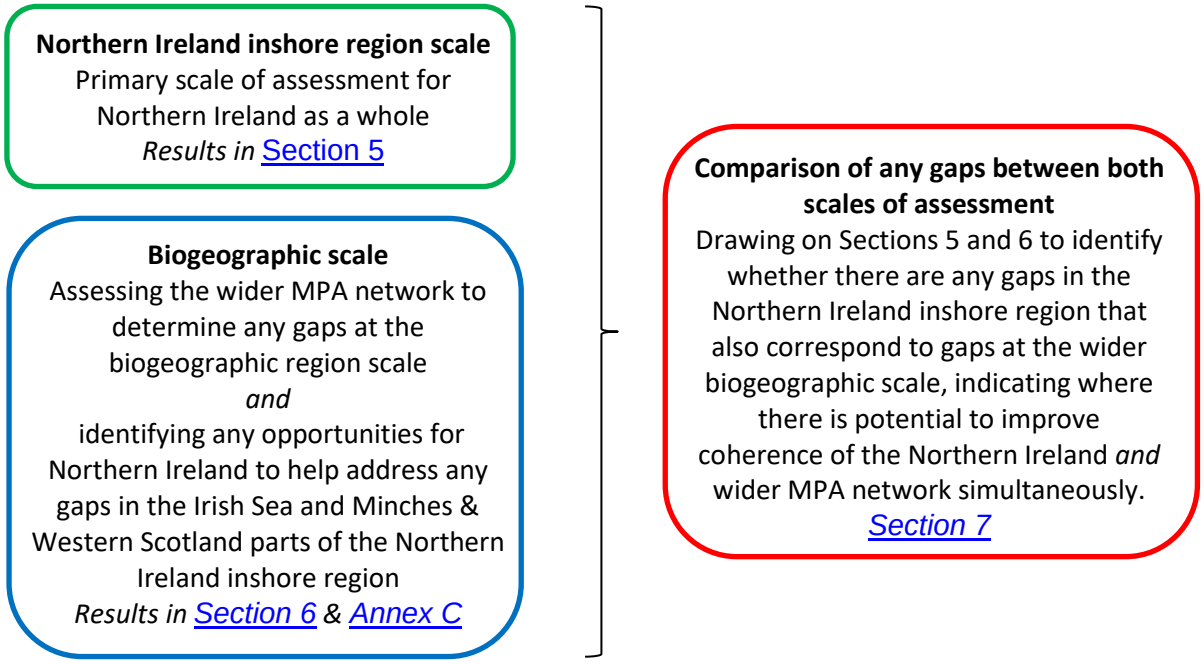


Figure 1. The spatial scales used to assess the ecological coherence of the Northern Ireland MPA network (green and blue boxes) and the structure of this report (all boxes).

DAERA asked for the assessment to be scientific and independent, allowing JNCC to draw impartial conclusions on the status of the Northern Ireland MPA network. Nevertheless, JNCC worked with DAERA technical staff throughout the assessment to obtain data on the habitats and species protected in Northern Ireland MPAs and to check that results were accurate and scientifically valid. JNCC also sought advice from DAERA to ensure that the conclusions presented in this report were policy relevant.

2. Criteria for identifying gaps in the MPA network

The design of the UK MPA network is underpinned by OSPAR Commission[3] guidance on developing an ecologically coherent network of MPAs. In 2012 the UK Government and the Devolved Administrations published a statement setting out the broad principles that have been applied in a UK context[1]:

> *"We are aiming for a UK contribution to an ecologically coherent MPA network in the North East Atlantic, in accordance with the OSPAR Convention which is an evolving scientific concept. The OSPAR Commission guidance outlines five main elements to assist in interpreting the concept of an ecologically coherent MPA network. The principles which underpin an ecologically coherent network are widely accepted and supported by the scientific community and by the administrations.*
>
> *The five main OSPAR principles guiding the process are:*
>
> ***Features:** Sites should represent the range of species, habitats and ecological processes in the area. The proportion of features included in the MPA network should be determined on a feature-by-feature basis, considering whether features that are in decline, at risk or particularly sensitive are of a higher priority and would benefit from a higher proportion being protected by MPAs.*
>
> ***Representativity:** To support the sustainable use, protection and conservation of marine biological diversity and ecosystems, areas which best represent the range of species, habitats and ecological processes.*
>
> ***Connectivity:** This may be approximated by ensuring the MPA network is well distributed in space and takes into account the linkages between marine ecosystems.*
>
> ***Resilience:** Adequate replication of habitats, species and ecological processes in separate MPAs in each biogeographic area is desirable where possible. The size of the site should be sufficient to maintain the integrity of the feature for which it is being selected.*
>
> ***Management:** MPAs should be managed to ensure the protection of the features for which they were selected and to support the functioning of an ecologically coherent network."*

The principles of 'Features', 'Representativity', 'Resilience' and 'Connectivity' informed our selection of MPA network criteria for evaluating the whether the Northern Ireland network of MPAs is ecologically coherent. These principles were considered in the selection of the

[3] OSPAR Commission (2006). Guidance on developing an ecologically coherent network of OSPAR marine protected areas. No. 2006-03. Available at: http://jncc.defra.gov.uk/pdf/06-03e_Guidance%20ecol%20coherence%20MPA%20network.pdf

Northern Ireland Marine Conservation Zones[4] and were also been adopted in similar assessments recently undertaken for Secretary of State waters[5,6,7] and Welsh waters[8].

This current assessment only reviews MPA network design and does not consider the principle of management [of human activities]. However, management schemes are in place for two European Marine Sites in Northern Ireland (Strangford Lough and Rathlin) and are under development for another (Skerries and Causeway). DAERA has initiated a programme to develop management plans and the necessary management measures for the remaining MPAs within the Northern Ireland network and a future assessment will be undertaken to review the effectiveness of management measures.

2.1 Assessment criteria

The criteria for assessing the MPA network in Northern Ireland were based on a combination of the those set out in the MCZ Ecological Network Guidance (ENG)[9] (representativity, replication and connectivity) and the OSPAR guidelines for adequacy of broad-scale habitat protection[3]. The criteria were tailored to the different network requirements of broad-scale habitats compared to habitats, species and geological/geomorphological features of conservation importance in Northern Ireland - Priority Marine Features and proposed MCZ (pMCZ) features.

For the purposes of this present assessment (specifically question 2 of the analysis), a gap was considered to exist in the MPA network if any of the following criteria were ***not*** met:

Crit. i. All Northern Ireland Priority Marine Features, pMCZ features and broad-scale habitat features are represented in the MPAs in the Northern Ireland inshore region

a. Ensures that at least one example of each broad-scale habitat, PMF/pMCZ habitat, PMF/pMCZ species, and pMCZ geological/geomorphological feature has been protected.
b. This is relevant to the OSPAR principle of **representativity**.

Crit. ii. Two examples of each broad-scale habitat feature are protected in the Northern Ireland inshore region and each 'Charting Progress 2' biogeographic region

a. Ensures that all broad-scale habitats (derived from the current EUNIS level 3 habitats[10]) are represented within the network in each biogeographic region. This is relevant to the OSPAR principle of **representativity**; and,
b. Ensures a degree of **replication** of broad-scale habitats within the network. This is relevant to the OSPAR principle of **resilience**.

[4] Information available at: https://www.daera-ni.gov.uk/publications/guidance-selection-and-designation-marine-conservation-zones-mczs-northern-ireland
[5] JNCC (2014). Identifying the remaining MCZ site options that would fill big gaps in the existing MPA network around England and offshore waters of Wales & Northern Ireland. Available at: http://jncc.defra.gov.uk/pdf/140224_BigGapsMethod_v8.pdf
[6] JNCC (2014). Assessing progress towards an ecologically coherent network of MPAs in Secretary of State Waters in 2014. Available at: http://jncc.defra.gov.uk/pdf/JNCC_NetworkProgressInSoSWaters_2014.pdf
[7] JNCC (2016). Assessing progress towards an ecologically coherent MPA network in Secretary of State Waters in 2016: Methodology. Available at: http://jncc.defra.gov.uk/pdf/JNCC_NetworkProgressInSoSWaters2016_Methods_Final.pdf
[8] JNCC (2016). Assessing the contribution of Welsh MPAs towards an ecologically coherent MPA network in 2016. Available at: http://jncc.defra.gov.uk/pdf/JNCC_NetworkProgressWelshWaters_Final.pdf
[9] Natural England and the Joint Nature Conservation Committee (2010). *The Marine Conservation Zone Ecological Network Guidance*. Sheffield and Peterborough, UK. Available at: http://jncc.defra.gov.uk/pdf/100705_ENG_v10.pdf
[10] Available at: http://jncc.defra.gov.uk/page-3365

Crit. iii. **Two examples of each Northern Ireland Priority Marine Feature and pMCZ feature are protected in the Northern Ireland inshore region**
and
Three examples of each Northern Ireland Priority Marine Feature and pMCZ feature are protected in each 'Charting Progress 2' biogeographic region[11]

a. Ensures that rare and/or threatened species, habitats and geological/geomorphological features are afforded specific protection in the network, which is relevant to the OSPAR **features** principle;
b. Ensures **replication** of rare and/or threatened species and habitats within the network, which is relevant to the OSPAR **resilience** principle; and
c. Recognises that these features should be assessed at the wider biogeographic scale where possible, but where these species and habitats are only recognised as a conservation priority in Northern Ireland and data are not available in the wider biogeographic region, they will need to be assessed at the Northern Ireland inshore-scale only.

Crit. iv. **The proportion by area of each subtidal broad-scale habitat within MPAs exceeds the minimum OSPAR guideline of 10% within the Northern Ireland inshore region and each 'Charting Progress 2' biogeographic region**

a. The proportion of each broad-scale habitat afforded protection within the network (known as '**adequacy**') is relevant to the OSPAR **features** principle;
b. Ensures that an appropriate amount of each habitat is represented within the network for it to be effective and ecologically viable; and,
c. Owing to a lack of mapped data showing the extent of intertidal and deep-sea broad-scale habitats, the adequacy assessment was restricted to subtidal broad-scale habitats that occur on the shelf area only.

Crit. v. **Sites affording protection to the same broad habitat type (equivalent to current EUNIS level 2) are not further than 80 km apart from each other**

a. Applying a basic distance separation criterion increases the likelihood that sites with similar features are ecologically connected to each other, which is relevant to the OSPAR **connectivity** principle.

[11] Applied only to a subset of Northern Ireland Priority Marine Features and proposed Marine Conservation Zone features that are listed on the UK MPA network features list (see http://jncc.defra.gov.uk/page-7438) and have data available at the wider biogeographic region scale. See Annex A for further information. Two Northern Ireland pMCZ features (*Brittlestar beds* and *Cepphus grylle*) that are not listed on the UK MPA network features list were also assessed at the biogeographic scale, but against a target of two (rather than three) protected replicates.

3. Assessment scope and input data

The geographic scope of this network assessment was defined by the extent of the Northern Ireland inshore region and the wider biogeographic regions within which the Northern Ireland inshore region lies (Figure 2). The range of habitats and species assessed was defined by the features relevant to MPA-based conservation in Northern Ireland and the MPA designation types occurring here and in the wider biogeographic regions. Datasets listing the MPAs and their protected features in the Northern Ireland inshore region and the wider biogeographic regions were collated to inform the assessment.

3.1 Biogeographic regions

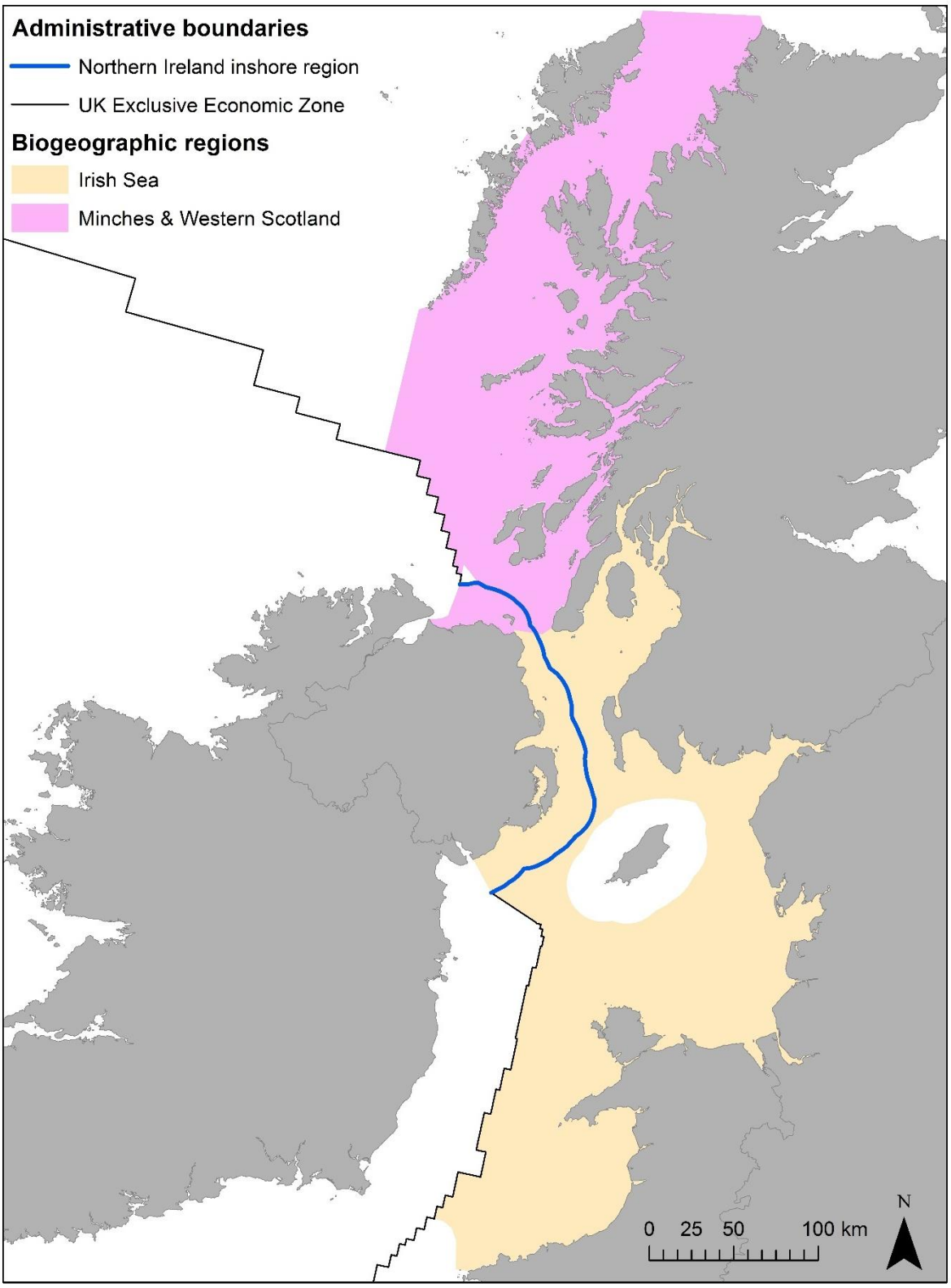
The guidance set out by OSPAR indicates that the network should take biogeographic variation into account when considering the protection of MPA features. In line with the approach taken for previous assessments in 2013, 2014 and 2016 for Defra[5,6,7] and Welsh Government[8], this present assessment used the regional seas developed for the Charting Progress initiatives (specifically the 'Charting Progress 2' report)[12] to provide the biogeographic context. Assessing the Northern Ireland inshore MPAs within the wider biogeographic context will determine how Northern Ireland MPAs contribute to the wider UK MPA network and whether there are any gaps in the wider network that Northern Ireland could help to address with additional protection of features in future.

Two Charting Progress 2 (CP2) regions overlap with the Northern Ireland inshore region (Figure 2) and these provided the biogeographic scale of the current assessment:

- Irish Sea; and
- Minches & Western Scotland.

The Irish Sea region includes sections of Northern Ireland, English, Welsh and Scottish waters but excludes Isle of Man and Republic of Ireland territorial waters. The Minches and Western Scotland region incorporates sections of Northern Ireland and predominantly Scottish waters. Consequently, MPAs outside of the Northern Ireland inshore region but within these biogeographic regions form part of the MPA network at this wider biogeographic scale and therefore data for these sites were included in this assessment.

[12] Charting Progress 2. Published by the Department for Environment, Food and Rural Affairs on behalf of the UK Marine Monitoring and Assessment Strategy community. Available online at: http://chartingprogress.defra.gov.uk/



UK Exclusive Economic Zone and Northern Ireland inshore region limits contain UKHO data © Crown copyright and database right 2018. The exact limits of the EEZ are set out in The Exclusive Economic Zone Order 2013. Not to be used for navigation. © JNCC (January 2018)

Figure 2. Northern Ireland inshore region in the context of the broader Charting Progress 2 (CP2) biogeographic regions.

3.2 Features for consideration

The MPA features considered in this assessment are listed in full in Annex A and comprised:

- Marine broad-scale habitats;
- Northern Ireland Priority Marine Features (PMFs) considered to be afforded protection under the existing MPA network; *and*
- Proposed Northern Ireland MCZ (pMCZ) features, including component habitats.

Broad-scale habitats were derived from level 3 of the EUNIS habitat classification[13] and were used as a proxy for the range of more detailed seabed biotopes likely to occur in the Irish Sea and Minches & Western Scotland regions. This assessment included 24 littoral, infralittoral, circalittoral and deep-sea broad-scale habitats, encompassing the range of broad environmental conditions in these regions and providing consistency with previous MPA network assessments conducted in the same and other parts of UK waters[5,6,7,8].

The Northern Ireland "PMFs considered to be afforded protection under the existing MPA network" were determined by DAERA in 2014[14] as a pre-requisite to identifying proposed Marine Conservation Zone (pMCZ) features for Northern Ireland. These PMFs include priority habitats, limited/low mobility species and highly mobile species of conservation importance in the Northern Ireland inshore region. PMF species for which MCZ designation (or MPA designation more broadly) was not considered appropriate in the 2014 selection process[15] were not included in this MPA network assessment.

Northern Ireland pMCZ features are habitats, limited/low mobility species, highly mobile species and geological/geomorphological features that DAERA identified for further protection in the Northern Ireland inshore region through the MCZ designation process[16]. Most of these features are in addition to the list of Northern Ireland PMFs, but six broad-scale habitats listed as pMCZ features overlap with the generic broad-scale habitats noted above. The pMCZ habitats also include some component (finer-scale) habitats that were included in this assessment in their own right, independent of their 'parent' broad-scale sediment habitat features.

Only the Northern Ireland PMFs that are also listed on the UK MPA network features list[17] (and therefore relevant to the wider UK MPA network) were assessed at the biogeographic scale (28 out of the 102 PMFs, see Annex A). The remaining 74 PMFs were only assessed in the Northern Ireland inshore region. The majority of pMCZ features were assessed at the wider biogeographic scale, except for *Coastal saltmarsh* and *Intertidal mudflats* (for which data were unavailable at the wider biogeographic scale, particularly within SSSIs) and the *Philine*

[13] The list of level 3 habitats was taken from the EUNIS Habitat Classification 2007; the classification is being revised and therefore the habitats listed at 'level 3' may differ in future versions.
[14] These features were selected from a broad list of PMFs to determine those that were already benefitting or could benefit from spatial protection measures in Northern Ireland. Although these features are already protected in MPAs to some degree, they have not previously been assessed in the context of their contribution to an ecologically coherent network. See Annex I, Tables 1.1 and 1.2 in: DoENI 2014. Marine Conservation Zones in the Northern Ireland inshore region: Justification report for the selection of proposed Marine Conservation Zone (pMCZ) features. Available online at: https://www.daera-ni.gov.uk/publications/marine-conservation-zones-northern-ireland-inshore-region-0
[15] Ibid., Annex I Tables 1.3 and 1.4. Reasons for exclusion from consideration in the Northern Ireland MCZ process included data deficiency and lack of site fidelity. Although harbour porpoise *Phocoena phocoena* PMF is listed in ibid. Table 1.4 it was included in the assessment as it is considered suitable for MPA designation and afforded protection in Northern Ireland.
[16] Tables 1-3 in the above reference.
[17] The UK MPA network features list is available at: http://jncc.defra.gov.uk/page-7438

aperta and Virgularia mirabilis on infralittoral mud and geological/geomorphological features (which are not listed as priority features for designation by other Administrations in the UK).

3.3 Marine Protected Areas and their protected features

The following types of MPA were included in the current assessment: Special Areas of Conservation (SACs) with marine components; Marine Conservation Zones (MCZs); Nature Conservation MPAs (NCMPAs) in Scottish waters; Areas of Special Scientific Interest (ASSIs) with marine biological components in Northern Ireland; and a small subset of Ramsar Sites (Figure 3).

The assessment used the most up-to-date data on the features afforded protection within the MPA network. JNCC and the Statutory Nature Conservation Bodies (SNCBs) are undertaking a cataloguing exercise, known as the 'UK MPA stocktake'[18], to create a standardised inventory of features protected in UK MPAs. Following the MPA stocktake procedure, DAERA compiled data for all the major MPA designation types in the Northern Ireland MPA network, creating a comprehensive catalogue of the broad-scale habitats and PMF/pMCZ features already protected.

Efforts to catalogue MPA protected features in the wider UK MPA network are at various stages of completion for each designation type and country. Data for English, Welsh and Scottish MPAs had to be collated from a variety of sources, compiled at different dates, to inform the assessment at the wider biogeographic scale.

Those completed datasets from the UK MPA stocktake used to identify features already protected in the MPA network were:

- Inshore Northern Ireland SACs, MCZs and ASSIs (July 2017);
- Offshore MPAs (SACs and MCZs) (March 2016);
- Inshore Welsh SACs (March 2016);
- Inshore Scottish SACs (March 2016); *and*
- Inshore Scottish NCMPAs (March 2017).

Two interim datasets were provided for this assessment:

- Inshore English SACs and MCZs (January 2017); *and*
- Scottish Ramsar Sites (March 2017).

The UK MPA stocktake evaluates the habitats and species present in MPAs to determine whether these can be considered protected and if they contribute a viable replicate of that feature to the MPA network. Where data were derived from interim sources, JNCC assumed the protected MPA features identified were viable replicates of those features.

The following MPA designation types were not included in this assessment:

- Sites of Special Scientific Interest (SSSIs) with marine biological components in England, Wales and Scotland, as protected feature data were not available;
- Special Protection Areas (SPAs), as an approach for identifying the non-avian marine features afforded protection in SPAs has not yet been agreed by the SNCBs;
- Ramsar Sites in Northern Ireland, as these protect bird species that are not listed as PMF or pMCZ species; *and*
- Ramsar Sites in England and Wales, as protected feature data were not available.

[18] Further information available at: http://jncc.defra.gov.uk/page-7438

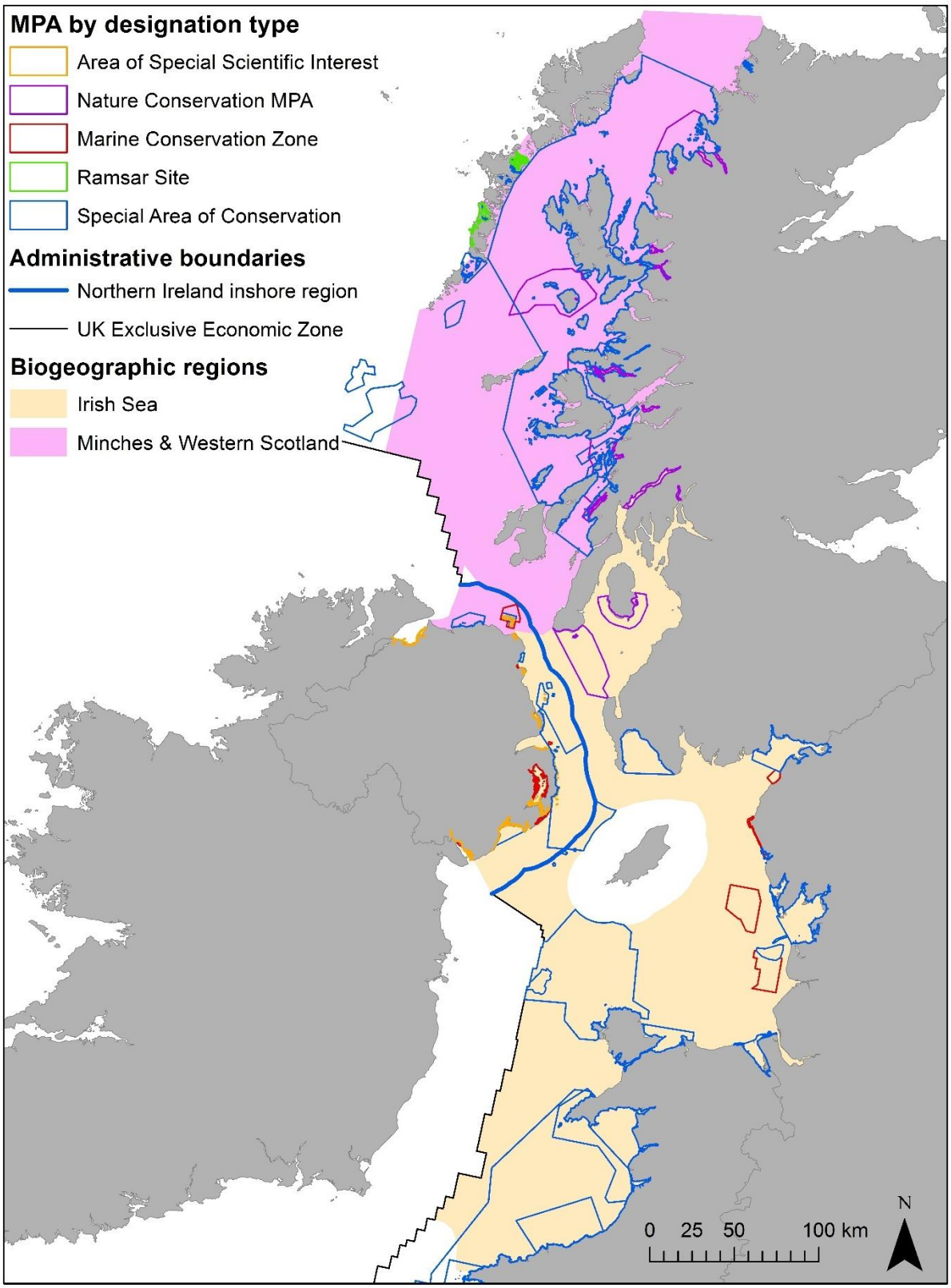


Figure 3. Marine Protected Areas (MPAs) included in the MPA network assessment in the Irish Sea and Minches & Western Scotland biogeographic regions. Only MPAs protecting broad-scale habitats, Northern Ireland Priority Marine Features or proposed Marine Conservation Zone features were included in this assessment.

As SSSIs, Ramsar Sites and SPAs afford protection to substantial areas of the intertidal zone[19], the exclusion of these sites may underestimate the degree of protection to intertidal habitats and species in the current MPA network. It should also be noted that some SPAs and Ramsar Sites may offer protection to subtidal features. However, as many of these designation types overlap and/or underpin other designations already included in the assessment (particularly ASSIs/SSSIs and Ramsar Sites within SACs), this underestimation is not expected to be sizeable, especially at the Northern Ireland inshore region scale.

3.4 Broad-scale habitat map

JNCC compiled a map of broad-scale habitats for the Irish Sea and Minches & Western Scotland regions to undertake area calculations for subtidal broad-scale habitats to assess adequacy of protection (criteria iv). This map combined the following data:

- A UK broad-scale habitat map of integrated survey and modelled datasets[20];
- A UK map of modelled broad-scale habitats (UKSeaMap 2016)[21]; *and*
- Additional survey datasets for Strangford Lough, Murlough and Dundrum, The Narrows and Fair Head provided by DAERA and the Agri-Food Biosciences Institute, Northern Ireland.

The resulting map showing the distribution of broad-scale habitats was a single layer without overlaps between habitats or component datasets, making it suitable for area calculations. The map was therefore used to calculate subtidal habitat cover within MPAs at the Northern Ireland inshore and wider biogeographic scales.

3.5 Spatial extent of protected features

SACs can protect multiple habitat features listed on Annex I of the EU Habitats Directive (known as Annex I habitats) and to encompass these, SAC site boundaries can be delineated to cover much larger areas than the extents of the component Annex I habitats alone. It is therefore more accurate to assess the area of those broad-scale habitats protected in SACs by calculating and aggregating the protection provided only within the known extent of the Annex I features themselves, as opposed to the total area of the broad-scale habitat encompassed within the site boundary. For analytical purposes, this method disregards patches of subtidal broad-scale habitats that occur within a site but are not protected as part of an Annex I habitat. However, where detailed maps showing the location of Annex I features within a SAC were not available, the site boundary had to be used as a crude proxy for Annex I feature extent.

JNCC collated the delineated extents of subtidal Annex I features using the latest mapped data from all SNCBs to analyse the area of subtidal broad-scale habitat protection in SACs.

In MCZs, site boundaries provide a suitable scale to calculate the areas of protected subtidal broad-scale habitats because these are formally and directly designated features. The full extent of any broad-scale habitat listed as a designated feature is protected inside a MCZ site boundary and the map of broad-scale habitats used in the present assessment shows these extents directly, so no additional designated feature boundaries are required. Designated feature delineations for NCMPAs were not readily available and therefore site boundaries were

[19] The focus of SPA management measures will be the avian qualifying features; therefore, this does not guarantee that full protection will be provided to habitats or other species features within SPAs.
[20] This included seabed habitat maps from surveys of several Northern Ireland SACs.
JNCC (2017). EUNIS habitats: full-coverage EUNIS level 3 layer integrating maps from surveys and broad-scale models version 9.6.2.
[21] JNCC (2017). UKSeaMap 2016: broad-scale habitat map for UK waters. Available online at http://jncc.defra.gov.uk/ukseamap

adopted as a proxy for the spatial extent of the broad-scale habitats afforded protection in these sites.

3.6 Limitations of the input data

JNCC identified the following limitations with the information used in the assessment:

- As data were not available for SSSIs (England, Scotland & Wales), SPAs and most Ramsar Sites, this present assessment may identify gaps for features that are already represented and replicated in the MPA network. This issue is most likely to only apply to intertidal features at the wider biogeographic scale, and is much less significant for the assessment of the Northern Ireland inshore region as ASSIs and their features were included.
- It was beyond the scope of the assessment to examine complex spatial configurations of replicates. The assessment could over or under estimate the number of replicates protected in the MPA network where spatial relationships between patches of habitat or populations of species require close examination to resolve the number of separate replicates. For example, a single patch of habitat might run contiguously between close but non-overlapping MPAs, but it would appear as separate replicates (one for each MPA) in the assessment[22], thus over-estimating the replication of that habitat feature.
- The assessment used a variety of data sources compiled at different times. Datasets from marine surveys are particularly subject to change as new data are collected frequently. Work on the UK MPA stocktake is also ongoing to build a standardised inventory of protected features in MPAs, to provide a comprehensive and consistent view of the MPA network. As these developments affect our knowledge of the features present in MPAs, our assessment of the gaps within the MPA network will be subject to change, particularly in the wider biogeographic regions where the MPA stocktake work is still to be completed.

Several limitations also apply to the broad-scale habitat map, specifically that:

- It lacked intertidal and deep-sea broad-scale habitat data around much of the Northern Ireland and Scotland coastlines, and therefore the adequacy assessment was only undertaken for subtidal broad-scale habitats (12 of the 24 broad-scale habitats);
- It included large areas where habitat distributions are derived from a habitat model or the interpolation of widely-spaced data, and where there may be limited groundtruthing and/or acoustic data;
- It has a coarse spatial resolution. Therefore, habitats typically occurring in small patches or narrow zones (e.g. S*ublittoral macrophyte-dominated sediment*) are likely to be under-represented in these maps; *and*
- Small patches of subtidal broad-scale habitat data are missing in near-shore areas around the coastlines of both biogeographic regions (accounting for <2% of the whole study area). Without evidence to indicate the types and extents of habitats occurring in these small areas of seabed, these patches were excluded from the assessment and therefore did not contribute to habitat area figures used to assess criteria iv.

[22] This issue was considered and corrected for among the clusters of MPAs (SACs, ASSIs and an MCZ) in the Strangford Lough and Murlough areas of the Northern Ireland inshore region.

4. Methods

Each MPA feature listed in Annex A was considered against the applicable MPA network criteria with a "yes" or "no" outcome indicating whether the criterion was met or not, respectively. These results were used to conclude whether there were any apparent gaps against any of the criteria for the given MPA feature. Any gaps were then reviewed by JNCC and DAERA to check their validity, particularly in relation to available data on the known distribution of the feature.

4.1 Assessment of the MPA network against network criteria

Crit. i. All Northern Ireland Priority Marine Features, pMCZ features and broad-scale habitat features are represented in MPAs in the Northern Ireland inshore region (i.e. at least one example has been protected)

Crit. ii. Two examples of each broad-scale habitat feature are protected in the Northern Ireland inshore region and each biogeographic region

Crit. iii. Two examples of each Priority Marine Feature and pMCZ feature are protected in the Northern Ireland inshore region
and
Three examples of each Priority Marine Feature and pMCZ feature are protected in each biogeographic region[23]

To assess these representativity and replication criteria, matrices were created to identify all MPAs in which the broad-scale habitat, PMF/pMCZ habitat and species features were protected, from which the number of replicates could then be counted. These tables included breakdowns at the following scales: the Northern Ireland inshore region; the two biogeographic regions; and the Northern Ireland inshore region divided by the biogeographic regions.

If there were no sites within a region indicating protection an MPA feature, then a gap for representativity was identified. In such circumstances, one example would need to be protected to meet the minimum network requirements for representativity. If there was one site within the region affording protection to a broad-scale habitat, or only one or two sites affording protection to a PMF/pMCZ habitat or species within the region, then further replicates would need to be protected to meet the minimum network criteria for replication.

In cases where a MPA straddled the boundary between two regions, the protected features of the site were reviewed to determine in which of the regions the feature could be counted as a viable replicate. To avoid multiple counts of the same replicate any overlap between the boundaries of MPAs in which the same type of MPA feature(s) were protected was examined to determine the number of replicates present. The number of replicates was also examined in Strangford Lough and Murlough where a single patch of habitat or population of a species could potentially occur across multiple designations that do not spatially overlap but do adjoin, protecting different parts of a single feature replicate.

Crit. iv. The proportion by area of each subtidal broad-scale habitat feature within MPAs exceeds the minimum OSPAR guideline of 10% within the Northern Ireland inshore region and each biogeographic region

[23] Applied only to a subset of Northern Ireland Priority Marine Features and proposed Marine Conservation Zone features that are listed on the UK MPA network features list.

JNCC made two separate area calculations to assess this criterion. Firstly, we calculated the total area coverage of each subtidal broad-scale habitat in the Northern Ireland inshore region and biogeographic regions. Secondly, we calculated the total area of each subtidal broad-scale habitat afforded protection in MPAs. Area totals were obtained by clipping the broad-scale habitat map to the scales required for each calculation, as listed below.

Scales for calculating the total coverage of each subtidal broad-scale habitat:

- Northern Ireland inshore region;
- Irish Sea and Minches & Western Scotland regions; *and*
- Northern Ireland territorial waters divided into the two biogeographic regions.

Scales for calculating total areas of habitats protected in MPAs (in addition to the above):

- MPA boundaries for MCZs, NCMPAs and Ramsar Sites[24]; *and*
- Annex I feature extents in SACs.

The areas of subtidal broad-scale habitats were calculated at each of these scales in Microsoft SQL-Server Management Studio (2008 R2)[25]. The total coverage of each broad-scale habitat was calculated from the areas of all habitat polygons found in the broad-scale habitat map at each of the scales listed above. The total area of each habitat protected across the MPAs was then calculated by adding together the areas of habitat polygons within Annex I feature extents in SACs and within the MPA boundaries of other designation types[26]. Habitat areas were then cross-referenced with the catalogue of broad-scale habitat features afforded protection by MPAs to ensure that habitats were excluded if they were shown to be present but not formally protected by an MPA. The areas of broad-scale habitats afforded protection in overlapping MPAs were included only once. Further details on the methods used to calculate broad-scale habitat areas are given in Annex B.

The percentage (by area) of habitat protected in MPAs, relative to the total area of habitat occurring in region, identified any shortfalls in adequacy under criteria iv for the Northern Ireland inshore region and each biogeographic region. Any broad-scale habitat type showing less than 10% being protected in MPAs was flagged as a gap. If this target was not met for a broad-scale habitat type with minimal total coverage in the Northern Ireland inshore region or wider biogeographic region (<0.1% of the region and <10 km^2 in total coverage) the shortfall was disregarded and not considered a 'gap'. This approach assumed that the very small area of unprotected habitat occurring outside of existing MPAs would not be viable for further protection.

Limitations in the assessment of criteria iv:

- Some broad-scale habitats protected in existing MPAs were not shown within these sites in the broad-scale habitat map. Data for these habitats were either not available when the map was compiled or were point data records that could not be used to quantify extent. As such, the areal contribution of these features could not be assessed and their extent is likely to have been underestimated. Correspondingly, the extent of habitats shown in their place in the broad-scale habitat map are likely to have been overestimated;
- Many parts of the broad-scale habitat map were derived from habitat models or based on the interpolation of widely-spaced data, with a minority of locations lacking habitat data altogether (see Section 3.6). These factors are likely to limit the accuracy of habitat area calculations. Consequently, there may be some cases where low confidence data will have contributed to the identification of an adequacy gap. Further assessment of these

[24] ASSIs do not protect subtidal broad-scale habitats and therefore were not included in the analysis of criteria iv.
[25] Area estimates were calculated in Albers Equal Area Conic Projection.
[26] The overlap between Annex I feature extents within MPAs was accounted for in the analysis; duplicate habitat areas were removed.

data (beyond the scope of this assessment) may reveal that such evidence would be inadequate to support further protection of the feature in the MPA network, and therefore it would not be possible to address the gap;

- The analysis assumed that broad-scale habitats in NCMPAs in Scottish waters were afforded protection across their entire extent within site boundaries. In practice, a broad-scale habitat will only be protected where its associated designated feature is present. As delineated extents of designated features were not available to refine the analysis, the area of habitats may have been overestimated in NCMPAs where the extents of designated Scottish MPA features did not encompass all habitat found within the site boundary; *and*
- The areas of finer-scale habitats such as *Sublittoral macrophyte-dominated sediment* are likely to have been underestimated. These habitats may be under-represented in the coarse resolution maps used to for this assessment.

Crit. v. Sites affording protection to the same habitat at broad habitat type are not further than 80km apart from each other.

JNCC undertook a simple assessment of connectivity by visually examining the contiguity of the MPAs that protect the same broad habitat features. This high-level assessment used the proximity of the broad habitats to represent the likelihood that sites with similar features are ecologically connected to each other. Although true connectivity relies on a complex interaction of physical and ecological processes at the habitat and species populations scales, this analysis assumed a degree of similarity between the habitats and species assemblages of MPAs protecting the same broad habitats. Three data layers were built to show the MPAs affording protection to the following three broad habitat types:

- Infralittoral rock and other hard substrata;
- Circalittoral rock and other hard substrata; *and*
- Sublittoral sediment.

A buffer of 40km radius[27] was plotted around the site boundary (in ArcGIS v10.1) for each MPA protecting a broad habitat type, producing maps of the potential coverage of connectivity. Gaps in the buffers between any sites were visually identified from the maps and thus represented a distance of more than 80km between MPAs protecting the same habitat. Sites causing any such gaps were deemed unconnected.

Limitations in the assessment of criteria v:

- This analysis assumed that linear distance (or proximity) between MPAs was the only factor acting on connectivity. Connectivity is influenced by a number of physical (such as tidal and oceanographic currents), chemical (such as acidification) and biological factors (such as location of source areas for propagules, disperal capability of propagules) and will vary between habitats and species, factors that cannot be taken into account in this high-level assessment. The analysis may therefore have overestimated or underestimated connectivity depending on the conditions and processes occurring within and between sites, and the distances over which these operate; *and*
- This analysis assumed that MPAs protecting the same broad habitat type protected similar habitat biotopes and species assemblages. In reality, the same broad habitats

[27] The 80km spacing was identified by Roberts et al. (2010) as a guideline for the greatest distance between sites supporting similar habitats to ensure sufficient ecological connectivity. Roberts, C.M., Hawkins, J.P., Fletcher, J., Hands, S., Raab, K. and Ward, S. 2010. Guidance on the size and spacing of Marine Protected Areas in England. NECR037, Sheffield: Natural England, 2010. Available at: http://publications.naturalengland.org.uk/publication/46009

may comprise a different suite of specific biological communities at each site, albeit with a overall degree of similarity. This assessment does not assess connectivity at a finer biological resolution than the broad habitat level due to a lack of spatial data at such detailed levels.

4.2 Reviewing shortfalls to identify gaps

Potential shortfalls in the protection of PMF/pMCZ features (identified under criteria i and iii) were reviewed by JNCC and DAERA to verify whether these could potentially be addressed at Northern Ireland inshore or biogeographic region scales. In some cases, the assessment process identified potential representativity or replication gaps, yet closer examination revealed that these should not be considered gaps due to:

- Very limited[28] or no evidence of viable patches/populations of the feature in the Northern Ireland inshore region or in the wider regions not already protected by MPAs; *or*
- A need for further survey work to determine whether the examples of the feature present in the Northern Ireland inshore region or wider regions could be considered as viable replicates to the network.

Where a potential representativity or replication gap had been identified, JNCC and DAERA used the following sources to verify that records of the PMF/pMCZ features occur beyond their current protection in MPAs:

- Broad-scale habitat map (as described in Section 3.4);
- Offshore Habitat Features of Conservation Importance version 1 – point and polygon records[29];
- Marine Recorder snapshot version 20170420 [30];
- Geodatabase of Marine Features adjacent to Scotland (GeMS) version 5 iteration 18;
- National Biodiversity Network (NBN) Atlas[31];
- OSPAR threatened and/or declining habitats in the North-East Atlantic – point and polygon records[32];
- Additional data held by DAERA (such as recent marine surveys) and other government departments and institutions; *and*
- Expert judgement by DAERA.

Limitations of the verification process:

- It was beyond the scope of this present review to thoroughly evaluate habitat patch sizes and/or species population sizes to confirm whether further viable replicates are present and currently unprotected. Instead, the presence of at least one record for broad-scale habitats and two records for PMF/pMCZ habitats and species (beyond existing MPA protection) was deemed sufficient to consider a gap as practically addressable. It was also not possible to run a confidence assessment for the records identified outside of existing MPAs. Further assessment of feature viability (and possibly additional data collection) would be required to determine whether any

[28] A minimum of one record for broad-scale habitats and two records for PMF/pMCZ habitats and species (beyond existing MPA protection) were deemed necessary to consider a gap as practically addressable.
[29] Accessed from: http://jncc.defra.gov.uk/page-6639
[30] Accessed from: http://jncc.defra.gov.uk/page-1599
[31] Accessed for black guillemot only, available from: https://nbnatlas.org/
[32] Accessed from: http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974&LAYERS=OSPARHabPoints,Region&zoom=2&Y=44.47179158789556&X=-17.461445309764684

potential new replicates could offer a viable contribution to the MPA network. This work may result in changes to the gaps identified in this assessment.

4.3 Determining final outcomes

Drawing on the assessments of each MPA feature (Annex A) against each network criteria, JNCC concluded whether overall 'MPA network gaps' occurred for each feature in the Northern Ireland inshore region (Section 5) and whether Northern Ireland could help to fill overall MPA network gaps at the wider biogeographic scale (Section 6). These outcomes were categorised as a simple "yes" or "no" according to whether a MPA network gap was identified.

Broad-scale habitat gap outcomes summarised the progress of the MPA network towards meeting the representativity, replication and adequacy criteria; where these criteria were not met a broad-scale habitat gap was identified. At the biogeographic scale, JNCC identified adequacy gaps for subtidal broad-scale habitats in the wider MPA network and considered these gaps relevant to Northern Ireland where there were corresponding gaps (<10% of habitat protected) in the Northern Ireland sections of these biogeographic regions.

PMF and pMCZ feature gap outcomes summarised the progress of the MPA network towards meeting the representativity and replication criteria, where verification had confirmed that any gaps could be practically addressed. JNCC also identified gaps where further protection of PMF/pMCZ features in the Northern Ireland inshore region would help to narrow or close representativity and replication gaps at the biogeographic region scale (where verified records occur outside of existing MPA protection in Northern Ireland). However, if two or more replicates had already been protected in the Northern Ireland sections of the regions, gaps at the wider regional scale were not considered as gaps for Northern Ireland.

4.4 Evidence quality assurance

JNCC's evidence quality assurance policy and guidance were applied throughout this assessment, with quality control checks carried out on the data used in the assessment and the results presented. Raw results were reviewed by DAERA technical staff who have an expert knowledge of the known distribution of habitats and species in Northern Ireland and their protection in MPAs. The methods and report were also reviewed internally by two senior JNCC staff members and JNCC's MPA Sub-group, a non-executive group of independent scientists who provide oversight and strategic direction to JNCC's MPA work.

5. Progress of the MPA network in the Northern Ireland inshore region

This section presents the current status of the MPA network in the Northern Ireland inshore region, when assessed against criteria for representativity, replication and adequacy (as described in Sections 2 and 4). The following sub-sections describe the protection afforded by the existing Northern Ireland MPA network, noting any gaps that could be addressed to improve the ecologically coherent nature of the network. Gaps were only identified where further records of a habitat (or further habitat extents *vis-a-vis* the adequacy criterion) are known beyond the protected replicates and extents in existing MPAs.

5.1 Broad-scale habitats

Intertidal broad-scale habitats were assessed against the criteria for representativity and replication (criteria i and ii). Subtidal broad-scale habitats were assessed against the representativity, replication and adequacy criteria (criteria i, ii and iv).

5.2 Broad-scale habitat representativity and replication

All 24 intertidal and subtidal broad-scale habitats known to occur in Northern Ireland are represented within MPAs in the Northern Ireland inshore region (Table 1) and 20 of these are also replicated. Of the four broad-scale habitats that are not replicated in the MPA network, only *Low energy circalittoral rock* is considered a replication gap[33]. The other three habitats were not considered gaps due to very limited or no evidence of viable patches occurring in the Northern Ireland inshore region beyond their existing protection in MPAs.

5.3 Adequacy of subtidal broad-scale habitat protection

Seven of the 12 subtidal broad-scale habitats are adequately protected in the Northern Ireland inshore region, with >10% of their total known extent protected in MPAs (Table 1). *Moderate energy circalittoral rock*, *Low energy circalittoral rock*, *Sublittoral coarse sediment* and *Sublittoral mud* (Figure 4) did not meet this threshold and these habitats also have shortfalls in the wider biogeographic regions (see Section 6). If further areas of these habitat were to be protected in Northern Ireland MPAs in the future, this would help to address gaps for both the MPA networks in the Northern Ireland inshore region and at the wider biogeographic scale (see Section 7.1). *Low energy infralittoral rock* is not considered a gap in the MPA network in Northern Ireland as no other viable patches of this habitat were identified in the Northern Ireland inshore region.

[33] Note that whilst Annex I Reefs (a habitat listed on Annex I of the EC Habitats Directive) will comprise broad-scale habitats, assessing the protection afforded to broad-scale habitats is not synonymous with assessing the protection afforded to Annex I Reefs. Any statement regarding the protection of rock habitat in this assessment relates specifically to that broad-scale habitat and does not relate to the sufficiency of Annex I Reefs protection.

Table 1. Representativity, replication and adequacy results for broad-scale habitats in the Northern Ireland inshore region. The final column draws on the results from the three assessment criteria to determine the overall outcome for the Northern Ireland MPA network. Gaps are only indicated where there are further habitat records or known habitat extent beyond those currently protected in the existing MPA network that could provide the opportunity for further protection. The percentage (by area) of habitat protected is provided for habitats that have not met the 10% adequacy criterion. The adequacy of intertidal (littoral) and deep-sea broad-scale habitats was not assessed (marked "N/A").

Broad-scale habitat	**Represented?**	**Replicated?** (>1 replicate)	**10% of habitat area protected?**	**MPA network gap?**
High energy littoral rock	Y	Y	N/A	No
Moderate energy littoral rock	Y	Y	N/A	No
Low energy littoral rock	Y	Y	N/A	No
Littoral coarse sediment	Y	Y	N/A	No
Littoral sand and muddy sand	Y	Y	N/A	No
Littoral mud	Y	Y	N/A	No
Littoral mixed sediments	Y	N	N/A	No
Coastal saltmarshes and saline reed beds	Y	Y	N/A	No
Littoral sediments dominated by aquatic angiosperms	Y	Y	N/A	No
Littoral biogenic reefs	Y	Y	N/A	No
High energy infralittoral rock	Y	Y	Y	No
Moderate energy infralittoral rock	Y	Y	Y	No
Low energy infralittoral rock	Y	Y	N - 1.0%	No
High energy circalittoral rock	Y	Y	Y	No
Moderate energy circalittoral rock	Y	Y	N - 4.2%	Yes
Low energy circalittoral rock	Y	N	N - 0.5%	Yes
Sublittoral coarse sediment	Y	Y	N - 0.5%	Yes
Sublittoral sand	Y	Y	Y	No
Sublittoral mud	Y	Y	N - 4.3%	Yes
Sublittoral mixed sediments	Y	Y	Y	No
Sublittoral macrophyte-dominated sediment	Y	Y	Y	No
Sublittoral biogenic reefs	Y	Y	Y	No
Deep-sea rock and artificial hard substrata	Y	N	N/A	No
Deep-sea mixed substrata	Y	N	N/A	No

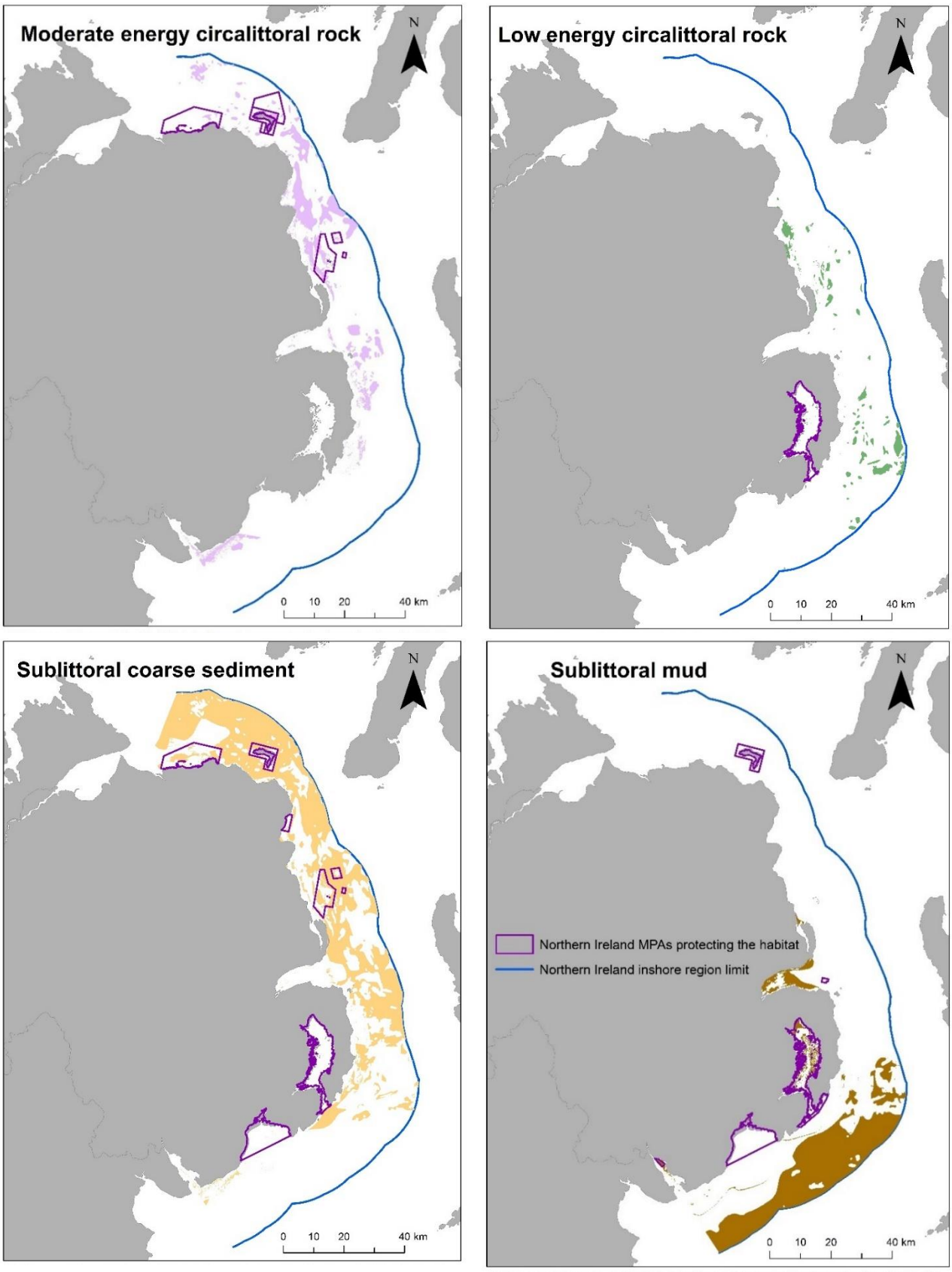


Figure 4. Distribution of *Moderate energy circalittoral rock* (purple polygons), *Low energy circalittoral rock* (green polygons), *Sublittoral coarse sediment* (yellow polygons) and *Sublittoral mud* (brown polygons) together with those MPAs in which they are protected features in the Northern Ireland inshore region.

5.4 Priority Marine Feature (PMF) and proposed MCZ (pMCZ) habitats and species

Northern Ireland PMF and pMCZ habitats and species were assessed against criteria for representativity and replication (criteria i and iii). Gaps were only identified where further verified records of the feature were available beyond protected replicates in existing MPAs.

5.4.1 Representativity of PMF/pMCZ habitats and species

Twenty of the 22 PMF/pMCZ habitats (Table 2) and all 93 PMF/pMCZ species (Table 3) are represented in MPAs in the Northern Ireland inshore region. Of the two PMF/pMCZ habitats not represented, only the Native Oyster (*Ostrea edulis)* beds habitat feature is considered a network gap. There are currently no records of *Cold water coral reefs* in the Northern Ireland inshore region and therefore this is not considered a representativity gap.

5.4.2 Replication of PMF/pMCZ habitats and species

Twelve out of the 22 PMF/pMCZ habitats (Table 2) and 56 of the 93 PMF/pMCZ species (Table 3) are replicated at least twice in MPAs in the Northern Ireland inshore region. For four of the habitats and 18 of the species not replicated, the lack of a second replicate in MPAs was not considered a gap due to limited or no evidence of viable patches/populations of the feature in the Northern Ireland inshore region not already protected by MPAs. Therefore, six replication gaps for PMF/pMCZ habitats and 19 replication gaps for PMF/pMCZ species were identified for the Northern Ireland inshore region.

The gap for Native Oyster (*Ostrea edulis)* beds and four of the PMF/pMCZ species gaps also relate to representativity and replication gaps at the wider biogeographic region scale (see Section 6). There would be an opportunity to address shortfalls at the biogeographic scale if further replicates of these features were to be protected in the Northern Ireland inshore region in the future (as summarised in Section 7.2).

Table 2. Representativity and replication results for Northern Ireland Priority Marine Feature (PMF) habitats and proposed MCZ (pMCZ) habitats in the Northern Ireland inshore region. The final column draws on the results from the representativity and replication assessment criteria to determine the overall outcome for the Northern Ireland MPA network. Gaps are only indicated where there are further verified records of the feature beyond those protected in the existing MPA network.

PMF and pMCZ habitat	**Represented?**	**Replicated?** (>1 replicate)	**MPA network gap?**
Blue mussel beds (intertidal)	Y	Y	No
Blue mussel beds (subtidal)	Y	N	Yes
Brittlestar beds	Y	N	Yes
Coastal saltmarsh	Y	Y	No
Cold water coral reefs	N	N	No
Estuarine rocky habitats	Y	N	Yes
Fragile sponge and anthozoan communities on subtidal rocky habitats	Y	Y	No
Horse mussel (*Modiolus modiolus*) beds	Y	N	Yes
Intertidal mudflats	Y	Y	No
Intertidal under-boulder communities	Y	Y	No
Littoral chalk communities	Y	Y	No
Maerl beds	Y	Y	No
Mud habitats in deep water	Y	N	Yes
Native oyster (*Ostrea edulis*) beds	N	N	Yes
Philine aperta and *Virgularia mirabilis* on infralittoral mud	Y	N	No
Sabellaria alveolata reefs	Y	N	No
Saline lagoons	Y	Y	No
Seagrass (*Zostera*) beds	Y	Y	No
Sea-pen and burrowing megafauna communities	Y	Y	No
Sheltered muddy gravels	Y	N	No
Subtidal chalk	Y	Y	No
Tide-swept channels	Y	Y	No

Table 3. Representativity and replication of Northern Ireland Priority Marine Feature (PMF) species and proposed MCZ (pMCZ) species in the Northern Ireland inshore region. The final column draws on the results from the representativity and replication assessment criteria to determine the overall outcome for the Northern Ireland MPA network. Gaps are only indicated where there are further verified records of the feature beyond those protected in the existing MPA network.

PMF and pMCZ species[34]	Represented	Replicated? (>1 replicate)	MPA network gap?
Aequipecten opercularis	Y	Y	No
Alcyonium hibernicum	Y	N	No
Amphilectus ovulum	Y	N	No
Anseropoda placenta	Y	Y	No
Antedon petasus	Y	Y	No
Antho brattegardi	Y	Y	No
Arachnanthus sarsi	Y	N	No
Archidistoma aggregatum	Y	Y	No
Arctica islandica	Y	N	Yes
Ascophyllum nodosum ecad var mackayi (mackaii)	Y	N	No
Asterina phylactica	Y	N	Yes
Asteropecten irregularis	Y	Y	No
Atelecyclus rotundatus	Y	Y	No
Atractophora hypnoides	Y	N	Yes
Atrina fragilis	N	N	No
Aureliania heterocera	Y	Y	No
Axinella damicornis	Y	Y	No
Axinella dissimilis	Y	Y	No
Biemna variantia	Y	N	No
Boltenia echinata	Y	Y	No
Bugula turbinata	Y	Y	No
Carpomitra costata	Y	Y	No
Caryophyllia inornata	Y	N	Yes
Caryophyllia smithii	Y	Y	No
Cepphus grylle	Y	N	Yes
Cerastoderma glaucum	Y	N	No
Cestopagurus timidus	Y	N	Yes
Chlamys varia	Y	N	Yes
Clathria barleei	Y	Y	No
Corystes cassivelaunus	Y	Y	No
Crenella decussata	Y	N	Yes
Cruoria cruoriaeformis	Y	Y	No
Cumanotus beaumonti	Y	Y	No
Cuthona concinna	Y	Y	No
Desmarestia dresnayi	Y	N	No
Diazona violacea	Y	N	Yes

[34] Taxonomic group names and common names are provided in Annex A.

PMF and pMCZ species[35]	Represented	Replicated? (>1 replicate)	MPA network gap?
Diphasia alata	Y	Y	No
Diphasia nigra	Y	Y	No
Dipturus batis	Y	N	Yes
Edwardsia timida	Y	N	No
Erato voluta	Y	N	No
Eubranchus doriae	Y	N	Yes
Eurypon coronula	Y	N	No
Glossobalanus sarniensis	Y	N	No
Halecium plumosum	Y	Y	No
Haliclystus auricula	Y	Y	No
Homarus gammarus	Y	Y	No
Hymedesmia cohesibacilla	Y	Y	No
Hymedesmia rathlinia	Y	Y	No
Hymerhabdia typica	Y	Y	No
Inachus leptochirus	Y	Y	No
Iophon hyndmani	Y	Y	No
Labidoplax media	Y	Y	No
Leptasterias muelleri	Y	Y	No
Leptosynapta bergensis	Y	N	Yes
Lissodendoryx jenjonesae	Y	Y	No
Lytocarpia myriophyllum	Y	Y	No
Microciona elliptichela	Y	Y	No
Munida rugosa	Y	Y	No
Mycale cf. contarenii	Y	N	No
Mycale lingua	Y	N	No
Mycale similaris	Y	N	No
Myxilla cf. rosacea	Y	Y	No
Palinurus elephas	Y	N	Yes
Palio dubia	Y	Y	No
Paracucumaria hyndmani	Y	N	Yes
Parazoanthus anguicomus	Y	Y	No
Parazoanthus axinellae	Y	N	No
Pecten maximus	Y	Y	No
Pentapora foliacea	Y	Y	No
Phocoena phocoena	Y	Y	No
Phymatolithon calcareum	Y	Y	No
Plocamiancora arndti	Y	Y	No
Polyplumaria flabellata	Y	Y	No
Porania pulvillus	Y	Y	No
Pycnoclavella stolonialis	Y	Y	No
Pyura microcosmus	Y	Y	No
Sabellaria alveolata	Y	N	Yes

[35] Taxonomic group names and common names are provided in Annex A.

PMF and pMCZ species[36]	Represented	Replicated? (>1 replicate)	MPA network gap?
Schmitzia hiscockiana	Y	Y	No
Schmitzia neapolitana	Y	N	No
Solaster endeca	Y	N	Yes
Spanioplon armaturum	Y	Y	No
Spongionella pulchella	Y	Y	No
Stelletta grubii	Y	N	Yes
Stenogramme interrupta	Y	Y	No
Stomphia coccinea	Y	Y	No
Stryphnus ponderosus	Y	N	Yes
Synoicum incrustatum	Y	Y	No
Tamarisca tamarisca	Y	Y	No
Tethya hibernica	Y	Y	No
Thecacera pennigera	Y	Y	No
Thyonidium drummondi	Y	N	No
Tonicella marmorea	Y	N	Yes

5.5 Proposed MCZ (pMCZ) geological and geomorphological features

Six pMCZ geological and geomorphological features were assessed against the criteria for representativity and replication. Two of the six geological and geomorphological features (Table 4) are represented and replicated within MPAs in the Northern Ireland inshore region. Representativity and replication gaps occur for *Glacial process features* and *Marine process features*. Representativity gaps (and potentially replication gaps) are likely to apply to *Mass movement features* and *Seawards extension features* but further research is required to understand their occurrence in the Northern Ireland inshore region.

Table 4. Representativity and replication of Northern Ireland pMCZ geological and geomorphological features in the Northern Ireland inshore region.

pMCZ geological/geomorphological feature	Represented?	Replicated? (>1 replicate)	MPA network gap?
Glacial process features	N	N	Yes
Marine process features	N	N	Yes
Mass movement features	N	N	Yes
Features indicating past change in relative sea level	Y	Y	No
Geological process features	Y	Y	No
Seawards extension features	N	N	Yes

[36] Taxonomic group names and common names are provided in Annex A.

5.6 Connectivity of broad habitats

An assessment of the distance between MPAs protecting similar broad habitat types found that these protected habitats are generally well connected in the Northern Ireland inshore region and there are no significant gaps in connectivity at this scale. Details of this assessment can be found in Annex C.

6. Assessment of the wider MPA network at the biogeographic scale

The MPA network in the wider Irish Sea and Minches & Western Scotland regions was assessed to understand what is currently protected and to identify any potential shortfalls against the assessment criteria. The results would give some indication of how the Northern Ireland MPA network could potentially contribute to furthering an ecologically coherent network at the broader biogeographic scale in the future (results are shown in Annex C). The following sub-sections briefly describe the existing protection of features and possible overall shortfalls at the biogeographic region scale, followed by a summary of the wider network gaps relevant to Northern Ireland.

Northern Ireland's current contribution to the wider MPA network was analysed as a prerequisite to identifying how Northern Ireland MPAs could potentially contribute further by addressing biogeographic-scale network gaps. This analysis considered the Northern Ireland inshore region divided by the two biogeographic regions, and included a verification step by JNCC and DAERA to confirm whether further records of features, beyond existing MPA protection, occur in the Northern Ireland sections of these regions. The results at this scale of assessment are presented in Annex D and informed the identification of biogeographic-scale network gaps relevant to Northern Ireland as described in this present section[37].

Representativity and replication gaps for Northern Ireland were only identified where further protection of habitats and species known to occur in the Northern Ireland sections of the regions would help to address representativity and replication gaps in the wider MPA network. However, if two or more replicates have already been protected in the Northern Ireland sections of the wider region, any shortfalls at the biogeographic region scale were not considered a gap for Northern Ireland.

Subtidal broad-scale habitat adequacy gaps were only identified if currently unprotected habitat was available in the Northern Ireland inshore region that could be protected to help address shortfalls at the wider biogeographic scale. However, if the habitat was already adequately (>10%) protected in the Northern Ireland section of the relevant CP2 region these cases were not considered a gap for Northern Ireland. Where broad-scale habitats are already adequately protected in the Northern Ireland inshore region there could still be opportunities to protect more habitat and further contribute to shortfalls at the wider biogeographic region (beyond the proportionate 10% contribution already made by Northern Ireland) but these are not described here.

6.1 Broad-scale habitats

Results at the biogeographic region scale

In the Irish Sea and the Minches & Western Scotland regions, all 24 broad-scale habitats assessed are represented and all but three broad-scale habitats are replicated in the existing UK MPA network (Table AC.1). However, shortfalls in the amount of habitat protected (<10% of their known extent protected in MPAs) were found for two rock and two sediment broad-scale habitats in the Irish Sea region and five rock and four sediment broad-scale habitats in the Minches & Western Scotland biogeographic region (Table AC.1, Annex C).

[37] Note that the opportunities for Northern Ireland to address biogeographic-scale network gaps were identified using the results of this additional analysis of the Northern Ireland MPA network divided by region, and not the results of the Northern Ireland MPA network as a whole (Section 5). This approach is consistent with MPA network assessments undertaken for Welsh waters and Secretary of State waters and aims to ensures that biogeographic variation is accounted for in MPA network design. Some gaps are shared between the biogeographic and the Northern Ireland inshore region scales, and these are described in Section 7.

MPA network gaps for Northern Ireland

Four of the adequacy shortfalls at the biogeographic region scale are considered as gaps for Northern Ireland. Three of these cases occur in the Irish Sea region for *Moderate energy circalittoral rock*, *Low energy circalittoral rock* and *Sublittoral coarse sediment*, and one occurs in the Minches & Western Scotland region for *Sublittoral coarse sediment*. The amount of these habitats protected in Northern Ireland MPAs could be increased for Northern Ireland to make a proportionate contribution to the UK MPA network at the wider region level.

6.2 PMF/pMCZ habitats

Results at the biogeographic region scale

Representativity and replication criteria were assessed for all but five Northern Ireland PMF/pMCZ habitats at the biogeographic region scale[38]. Fourteen of the 17 PMF/pMCZ habitats are represented in both the Irish Sea and Minches & Western Scotland regions (Table AC.2, Annex C). Twelve of the habitats are replicated in the UK MPA network in the Irish Sea region and 10 of the habitats are replicated in the Minches & Western Scotland region.

After reviewing these results, JNCC concluded that there are representativity and replication gaps for *Subtidal chalk* and Native Oyster (*Ostrea edulis)* beds and a replication gap for *Littoral chalk communities* in the Irish Sea region. In the Minches & Western Scotland region there is a replication gap for Native Oyster (*Ostrea edulis)* beds.

MPA network gaps for Northern Ireland

Native Oyster (*Ostrea edulis)* beds are not sufficiently represented or replicated in the Northern Ireland MPA network (see Section 5.4.2.). Providing further protection to this habitat in MPAs within the Northern Ireland section of the Minches & Western Scotland region would help to reduce the replication gap for this habitat in the wider UK MPA network.

6.3 PMF/pMCZ species

Results at the biogeographic region scale

Representativity and replication criteria were assessed for a subset of 20 of the Northern Ireland PMF/pMCZ species assessed in the Northern Ireland inshore region. Many species on the PMF list are only considered a priority for MPA protection in Northern Ireland (Annex A), therefore these were not assessed at the biogeographic scale.

In the Irish Sea region, 18 of 20 PMF/pMCZ species are represented in the UK MPA network in the Irish Sea region and only three species met the minimum replication target of >2 protected replicates (Table AC.3, Annex C). In the Minches & Western Scotland region, 16 species were sufficiently represented and only three species are replicated. After reviewing these results, JNCC concluded that there are 14 gaps for PMF/pMCZ species in the Irish Sea region and 17 in the Minches & Western Scotland region.

[38] Data were not available at the biogeographic region scale for *Coastal saltmarsh*, *Intertidal mudflats* and *Saline lagoons*. *Philine aperta and Virgularia mirabilis on infralittoral mud* is not on the UK MPA network features list and therefore data were also unavailable at the biogeographic scale. The *Blue mussel beds* feature was not assessed as separate intertidal and subtidal features at the biogeographic scale; these two types are not considered as separate features on the UK MPA network features list (nor are they considered separately for designation by other Administrations) and were therefore aggregated for this analysis.

MPA network gaps for Northern Ireland

Eight of the gaps at the Irish Sea biogeographic scale and three of the gaps at the Minches & Western Scotland scale are considered gaps for the Northern Ireland MPA network (as indicated in the final column of Table AC.3, Annex C). These gaps could be addressed by representing or protecting further replicates of PMF/pMCZ species in MPAs in the Northern Ireland inshore region.

7. Comparison of results for the Northern Ireland inshore region and the wider biogeographic scale

This present assessment of the Northern Ireland MPA network identified some gaps in the Northern Ireland inshore region and identified where Northern Ireland could also contribute to the network at the wider biogeographic scale (the two spatial scales of assessment shown in Figure 1). This section now considers which of the gaps identified for the Northern Ireland inshore region (Section 5) correspond to gaps at the wider biogeographic scale (Section 6). Acknowledging that gaps in the Northern Ireland inshore region are the greater priority for DAERA to act on, this section demonstrates how Northern Ireland could also contribute to the network at the wider biogeographic scale if the gaps identified for the Northern Ireland inshore region were to be addressed.

7.1 Broad-scale habitats

Broad-scale habitats were well represented and replicated in both the Northern Ireland inshore region and in the wider CP2 biogeographic regions. The only gap in replication found in the Northern Ireland inshore region, for *Low energy circalittoral rock*, does not correspond to replication gaps in either of the two regions. There are no representativity and replication gaps that apply to both scales of assessment simultaneously.

There were gaps in the adequacy of four subtidal broad-scale habitats in the Northern Ireland inshore region, three of which correspond to gaps for these habitats at the wider biogeographic scale (summarised in Table 5). Any additional protection of *Moderate energy circalittoral rock*, *Low energy circalittoral rock*, *Sublittoral coarse sedimen*t and *Sublittoral mud* habitats in the Northern Ireland inshore region would simultaneously contribute to the network at the wider biogeographic scale. The proportion of *Sublittoral mud* protected in the Irish Sea region is just less than 10% but, as the shortfall is within the margin of error of the adequacy analysis, this was not identified as a MPA network gap.

Table 5. Subtidal broad-scale habitats with gaps in the Northern Ireland inshore region and their corresponding status at the wider biogeographic scale. The gaps highlighted in this table relate to adequacy; percentages are the proportion (by area) of broad-scale habitat afforded protection in MPAs.

Subtidal broad-scale habitat with a gap in the Northern Ireland inshore region	% protected in Northern Ireland inshore region	% protected in the Irish Sea region	% protected in the Minches & Western Scotland region
Moderate energy circalittoral rock	4.2	5.2	No gap
Low energy circalittoral rock	0.5	0.5	No gap
Sublittoral coarse sediment	0.5	6.2	1.2
Sublittoral mud	4.3	No gap	No gap

7.2 PMF/pMCZ habitats and species

There are some gaps in the representativity and replication of Northern Ireland PMF/pMCZ habitats and species at the Northern Ireland inshore region scale that correspond to gaps for these features at the wider biogeographic region scale. Therefore, addressing gaps in the Northern Ireland inshore region could simultaneously help to reduce gaps in the wider biogeographic region (Table 6). If the representativity of Native Oyster (*Ostrea edulis)* beds is addressed in the Minches & Western Scotland part of the Northern Ireland inshore region, this will help to reduce the replication gap for this habitat at the biogeographic scale. Addressing replication gaps for *Cepphus grylle*, *Dipturus batis*, *Palinurus elephas* and *Paracucumaria hyndmani* in the Northern Ireland inshore region could simultaneously fill or help to reduce

replication gaps for up to three of these species in the wider Irish Sea region and up to two of these species in the wider Minches & Western Scotland region[39] (Table 6).

Table 6. Northern Ireland Priority Marine Feature (PMF) and proposed Marine Conservation Zone (pMCZ) habitats and species with gaps in the Northern Ireland inshore region, and their corresponding status in the wider biogeographic region(s). Gaps for the wider biogeographic regions are only indicated if: (1) shortfalls could be reduced by further protection of the feature in the Northern Ireland inshore region; and (2) two replicates of the feature are not already protected in the Northern Ireland inshore region. Gaps refer to representativity and/or replication network criteria. N/A indicates that the feature was not assessed at the biogeographic scale (see Annex A for more detail).

PMF/pMCZ habitat or species feature with a gap in the Northern Ireland inshore region	Gap in Northern Ireland inshore region	Gap in the Irish Sea region	Gap in the Minches & Western Scotland region
PMF/pMCZ habitat			
Blue mussel beds (subtidal)	Y	N/A	N/A
Brittlestar beds	Y	N	N
Estuarine rocky habitats	Y	N	N
Horse Mussel (*Modiolus modiolus*) beds	Y	N	N
Mud habitats in deep water	Y	N	N
Native oyster (*Ostrea edulis*) beds	Y	N	Y
PMF/pMCZ species			
Arctica islandica	Y	N	N
Asterina phylactica	Y	N/A	N/A
Atractophora hypnoides	Y	N/A	N/A
Caryophyllia inornata	Y	N/A	N/A
Cepphus grylle	Y	Y	N
Cestopagurus timidus	Y	N/A	N/A
Chlamys varia	Y	N/A	N/A
Crenella decussata	Y	N/A	N/A
Diazona violacea	Y	N/A	N/A
Dipturus batis	Y	Y	Y
Eubranchus doriae	Y	N/A	N/A
Leptosynapta bergensis	Y	N/A	N/A
Palinurus elephas	Y	N	Y
Paracucumaria hyndmani	Y	Y	N
Sabellaria alveolata	Y	N/A	N/A
Solaster endeca	Y	N/A	N/A
Stelletta grubii	Y	N/A	NA
Stryphnus ponderosus	Y	N/A	N/A
Tonicella marmorea	Y	N/A	N/A

[39] Which gaps Northern Ireland could potentially contribute towards at the biogeographic scale will depend on which CP2 region DAERA might opt for to address the gaps identified in the Northern Ireland inshore region.

8. Summary of the status of the MPA network in the Northern Ireland inshore region

Overall, the MPA network in the Northern Ireland inshore region is very close to reaching the policy objective of establishing an ecologically coherent network in Northern Ireland. The majority of MPA features of conservation interest are already represented and replicated in the MPA network. Only a small number of features do not meet the range of benchmarks set by the network criteria and these shortfalls typically relate to replication or the amount of habitat afforded protection, rather than to representation in the MPA network.

The status of the Northern Ireland MPA network and its remaining gaps are as follows:

- Within the Northern Ireland inshore region all broad-scale habitats are represented with the majority replicated in multiple MPAs; there are only a few gaps remaining in relation to the area of these habitats afforded protection in MPAs.

- There are a small number of gaps in the protection afforded to PMF/pMCZ habitats that could be addressed to ensure that MPAs sufficiently represent and replicate these features in the Northern Ireland inshore region.

- All PMF/pMCZ species are protected at least once in the existing MPA network, but 19 replication gaps were identified that could potentially be addressed in the Northern Ireland inshore region.

- Two of the six pMCZ geological and geomorphological features are represented and replicated. Representativity and replication gaps were identified for the four other features, but further research is needed to understand the occurrence of two of these features in the Northern Ireland inshore region.

- Broad habitat types in the Northern Ireland MPA network are well connected.

The gaps for the Northern Ireland inshore region are summarised in Table 7 below.

At a biogeographic scale, some gaps remain in the wider MPA network for the area of broad-scale habitats protected, and the representativity and replication of several PMF/pMCZ habitats and species in MPAs. Further protection of broad-scale habitats or PMF/pMCZ habitats and species in the Northern Ireland inshore region could reduce the gaps in the representativity, replication and adequacy of some features at the wider biogeographic scale.

Table 7. Summary of MPA network gaps for the Northern Ireland inshore region. Network gaps were identified for representativity (requiring one example protected in the Northern Ireland inshore region), replication (requiring two replicates) and adequacy (requiring protection to 10% of the area of subtidal broad-scale habitats). Gaps are only indicated where there are further verified records of the feature beyond those protected in the existing MPA network. More detail is provided in Section 5,Tables 1-3.

Feature assessed	MPA network gap in the Northern Ireland inshore region
Broad-scale habitat	
Moderate energy circalittoral rock	Adequacy (4.2% already protected)
Low energy circalittoral rock	Replication and adequacy (0.5% already protected)
Sublittoral coarse sediment	Adequacy (0.5% already protected
Sublittoral mud	Adequacy (4.3% already protected)
PMF/pMCZ habitat	
Blue mussel beds (Subtidal)	Replication
Brittlestar beds	Replication
Estuarine rocky habitats	Replication
Horse mussel (*Modiolus modiolus*) beds	Replication
Mud habitats in deep water	Replication
Native oyster (*Ostrea edulis*) beds	Representativity and replication
PMF/pMCZ species	
Arctica islandica	Replication
Asterina phylactica	Replication
Atractophora hypnoides	Replication
Caryophyllia inornata	Replication
Cepphus grylle	Replication
Cestopagurus timidus	Replication
Chlamys varia	Replication
Crenella decussata	Replication
Diazona violacea	Replication
Dipturus batis	Replication
Eubranchus doriae	Replication
Leptosynapta bergensis	Replication
Palinurus elephas	Replication
Paracucumaria hyndmani	Replication
Sabellaria alveolata	Replication
Solaster endeca	Replication
Stelletta grubii	Replication
Stryphnus ponderosus	Replication
Tonicella marmorea	Replication
pMCZ geological and geomorphological feature	
Glacial process features	Representativity and replication
Marine process features	Representativity and replication
Mass movement features	Further research required
Seawards extension features	Further research required

9. Ecological coherence: a moving target

Concluding whether an MPA network has become 'ecologically coherent' is challenging as there is no clear scientific agreement that determines when a network is complete. In practice, the success criteria for an ecologically coherent network will be a societal judgement[40]. For example, the target for adequacy in protecting at least 10% of broad-scale habitats is a 'policy target' recommended by OSPAR rather than an empirically-derived threshold. The target attempts to set a degree of protection that is acceptable to society within the wider context of management and use of the marine environment.

Although an ultimate endpoint cannot easily be defined, methods for assessing whether a network is ecologically coherent can be improved to provide more robust information on which to continue improving our understanding of the ecological principles of 'coherence' and 'function' of MPA networks. MPA network assessment criteria, such as those adopted here (Section 2.1) and in wider OSPAR assessments of the North-East Atlantic[41,42], continue to be reviewed and refined. The availability of new evidence is particularly important in shaping new approaches and changing in our understanding of the status of a given MPA network. The developing picture of our evidence base, further MPA designations and implementing effective management of MPAs will continue to change our understanding of ecological coherence and therefore attempting to complete the MPA network should be considered a fluid rather than a static goal.

The following sections outline some of the future developments that are likely to inform our understanding of whether the Northern Ireland MPA network is considered to be ecologically coherent.

9.1 Refining MPA network criteria

This present assessment applied guidelines, criteria and methods at the forefront of current understanding as to what constitutes an ecologically coherent network (consistent with assessments in other parts of the UK[40] and the wider North-East Atlantic[41]) to provide a comprehensive picture of the status of the Northern Ireland MPA network. Nevertheless, JNCC reviewed the assessment criteria (listed in Section 2.1) and undertook additional analyses to explore how the criteria could be further refined to improve our understanding of the Northern Ireland MPA network. These analyses are explained in more detail in Annex E.

9.1.1 Refining MPA network criteria by depth

Evidence for the range of biological communities associated with different seabed depths in UK waters has improved considerably in recent decades; JNCC recently published a new deep-water section of the Marine Habitat Classification for Britain and Ireland[43] to reflect the new evidence. Within the hierarchy of the classification[44], multiple biological communities

[40] JNCC advice on how to assess progress towards an ecologically coherent network of MPAs in Secretary of State waters - May 2016. In Annex I of JNCC (2016). Assessing progress towards an ecologically coherent MPA network in Secretary of State Waters in 2016: Methodology. Available at: http://jncc.defra.gov.uk/pdf/JNCC_NetworkProgressInSoSWaters2016_Methods_Final.pdf

[41] OSPAR (2013). An assessment of the ecological coherence of the OSPAR network of Marine Protected Areas in 2012. Available at: http://www.ospar.org/documents/dbase/publications/p00619/p00619_ecological_coherence_report.pdf

[42] OSPAR (2017). Summary status of the OSPAR network of marine protected areas 2016. OSPAR Thematic Assessment. Available at: https://www.ospar.org/site/assets/files/1879/mpa_status.pdf

[43] See: http://jncc.defra.gov.uk/page-6998 and Parry *et al*. 2015 available at http://jncc.defra.gov.uk/page-6997

[44] JNCC (2015) The Marine Habitat Classification for Britain and Ireland Version 15.03. Available at: jncc.defra.gov.uk/MarineHabitatClassification

(biotopes) are known to occur across the range of depths within higher-level broad-scale habitats. This variety is particularly noticeable for broad-scale subtidal sediment habitats that encompass a range of depths and physical conditions within infralittoral, shallow circalittoral, deep circalittoral zones. While the biotopes of shallower waters have been well documented, distinct biotopes have more recently been identified in the deeper (and further offshore) waters of the circalittoral zone.

This present assessment used broad-scale habitats (derived from level 3 of the EUNIS habitats classification) as a proxy to represent the range of habitats and species found in the Northern Ireland inshore region. However, this approach could be refined to consider whether the full range of more detailed biological communities (at EUNIS level 4 and beyond) are receiving protection in MPAs, particularly within subtidal sediment broad-scale habitats. However, there are limited spatial data of the full spatial distribution of these more detailed communities and therefore a direct assessment is not yet possible. JNCC explored two ways of refining the representativity and adequacy criteria, using seabed depth as a proxy for the range of biological communities potentially present in the Northern Ireland inshore region.

The first method assessed the areal coverage of MPAs in relation to seabed depth bands, quantifying the relative protection to shallow versus deeper waters as a crude proxy for the likelihood that MPAs are protecting the full range of biodiversity (Annex E Section AE.1). Depth bands of 0-10m; 10-75m; 75-200m; and >200m were selected, following an approach used in the study of OSPAR MPA network ecological coherence[45]. Our results indicated good coverage of MPAs across the seabed depth gradient in the Northern Ireland inshore region (Table AE.1 in Annex E), with MPAs occupying at least one third of the area of each depth band. However, this is not indicative of seabed habitat protection *per se*; North Channel cSAC was included in the analysis (and made a very substantial contribution to the results for the 10-75m and 75-200m depth bands) but does not currently protect seabed habitat[46].

The second method examined seabed habitat protection more directly by assessing the presence and extent of broad-scale habitats within MPAs across biological zones. The subtidal part of the Northern Ireland inshore region was divided into shallow shelf versus deeper shelf areas (Figure AE.1 in Annex E) using 'biozones'. These biozones (developed for the UKSeaMap project 2016[47]) were defined by the depth at which the seabed is no longer disturbed by wave action[48], creating a proxy for the different biological communities that could occur in higher versus lower energy environments in the circalittoral zone. This analysis found that notable proportions of most subtidal broad-scale habitats are protected in the shallow shelf waters of the Northern Ireland inshore region, but only a small proportion of some broad-scale habitats are protected in the deeper shelf area found further offshore (Annex E Section AE.2).

These two approaches are rudimentary and do not directly measure the representativity and adequacy of the biological communities particular to depth bands and biozones. Furthermore, the variety and distribution of biological communities within the Northern Ireland inshore region will not be determined by depth and wave action alone, as factors such as light penetration (particularly the contrast between the turbid waters of the Irish Sea versus the clearer waters of the Minches), currents and salinity will also have an important influence.

[45] OSPAR, (2013). An assessment of the ecological coherence of the OSPAR network of Marine Protected Areas. Available online at: http://www.ospar.org/documents/dbase/publications/p00619/p00619_ecological_coherence_report.pdf
[46] This site currently has harbour porpoise *Phocoena phocoena* as its only qualifying interest feature.
[47] JNCC (2017). UKSeaMap 2016: broad-scale habitat map for UK waters. Available online at http://jncc.defra.gov.uk/ukseamap
[48] Populus J. et al. (2017). EUSeaMap, a European broad-scale seabed habitat map. 174p. http://doi.org/10.13155/49975. Available online at http://www.emodnet-seabedhabitats.eu/outputs

Nevertheless, these analyses could help to refine the MPA network criteria adopted in this assessment (Section 2.1). If a broad depth band is poorly represented in MPAs it would suggest a potential gap in the ecological coherence of the network[45]. Likewise, if a disproportionately small amount of a broad-scale habitat is protected in deeper relative to shallow waters, the biological communities assumed to occur in that deeper, lower-energy seabed are unlikely to be as well represented as their shallower counterparts. Such proxy information could be useful for improving aspects of the MPA network in the absence of more detailed information about the range and distribution of biological communities in deeper shelf waters. However, further data are required to demonstrate the presence and extent of the biological communities present in the different zones to judge whether there are any shortfalls in the representation of these communities.

9.1.2 Site viability

The viability of a MPA network considers the size of the sites to ensure that species and habitats are likely to be able to persist and remain self-sustaining through natural cycles of variation[49]. This factor is another element of ecological coherence that could be considered to provide further insight into the completeness and functioning of an MPA network. JNCC undertook a rudimentary analysis to demonstrate how site viability could be considered in the context of the Northern Ireland MPA network.

The size of Northern Ireland MPAs protecting broad-scale habitats were compared against size thresholds suggested in the MCZ Ecological Network Guidance (ENG)[49] developed for the Defra Secretary of State waters around England, Wales and Northern Ireland. Sixty-seven percent of Northern Ireland MPAs[50] protecting broad-scale habitats meet or exceed the minimum area target (Annex E Section AE.3), comparing favourably with the site-size distribution across the wider biogeographic regions. Site size provides only a crude indicator of the likely persistence of habitats and species in MPAs, and the method applied here does not take into account the shape of sites, which can be far from simple. Nevertheless, this simple check can refine the assessment of whether the network is ecologically coherent beyond the five main network criteria adopted in this present assessment.

9.2 Changing evidence

The piecemeal development of new evidence on the presence and distribution of habitats and species can have a major effect on our understanding of MPA network coherence. Marine surveys continue to provide new and higher resolution data to map the biology of the seabed with increasing accuracy. The biodiversity of nearshore areas in the Northern Ireland inshore region is relatively well documented after several decades of dedicated survey effort. However, any future surveys in deeper shelf areas will help build our understanding of the types and distributions of biological communities in these areas and to confirm whether they differ from the communities already afforded substantial protection further inshore.

Modelling approaches are also frequently being refined to deliver higher confidence in our maps of benthic habitat distributions. Within the timescale of this assessment a new map predicting the distribution of rock features on the seabed has been developed for the Irish Sea and Minches and Western Scotland regions[51]. This new product suggests that less rock is exposed at the surface of the seabed than indicated by modelled data within the broad-scale habitat map used in this assessment; there is a corresponding increase in the extent of

[49] Natural England and the Joint Nature Conservation Committee (2010). *The Marine Conservation Zone Ecological Network Guidance*. Sheffield and Peterborough, UK. Available at: http://jncc.defra.gov.uk/pdf/100705_ENG_v10.pdf

[50] Excluding ASSIs, which are restricted to the intertidal zone and therefore typically small sites.

[51] JNCC (in prep). Semi-automated mapping of rock in the Irish Sea, Minches, western Scotland and Scottish continental shelf. JNCC Report. Will be made available at: http://jncc.defra.gov.uk/page-2132

sediment habitats. This result is likely to affect the scale of broad-scale habitat gaps identified, with shortfalls in the amount of subtidal sediment habitats likely to increase (where this assessment found that <10% of habitat is afforded protection) while shortfalls in the protection of rock habitat may reduce.

These assessments can only provide an indication of whether a MPA network is ecologically coherent using the evidence available at a snapshot in time. Further assessments over time will ensure that our understanding of their coherence and the further development of the network evolves in line with the changing evidence base.

9.3 Developments to the MPA network

This present assessment in 2017 considered the Northern Ireland inshore region within the context of wider biogeographic regions which include English, Welsh and Scottish waters. Any further MPA designation programmes within each of these countries will shape how the overall MPA network in each region changes with respect to the current criteria used to judge whether a network is ecologically coherent. As of mid-2017, Defra have indicated their intention to designate a further tranche of Marine Conservation Zones in Secretary of State waters, and the Welsh Government are considering further sites in Welsh waters. If any further MPAs are designated, the current shortfalls identified for the wider Irish Sea region (Section 6) will change and impact how Northern Ireland might act to address current gaps in the Northern Ireland inshore region.

The ongoing development of management measures to tackle the impact of human activities across the UK MPA network will influence the judgement of whether the network is ecologically coherent at both the biogeographic scale and in Northern Ireland specifically. To achieve an effective, ecologically coherent network it is imperative that MPAs are managed to ensure the effective protection of their features and thus, their contribution to an ecologically coherent network. Appropriate management of human activity needs to be implemented if the UK policy target for an ‘ecologically coherent network of well-managed MPAs’ is to be achieved. Once measures are more widely implemented, the effectiveness of the management in delivering conservation benefit to marine ecosystems will need to be assessed to provide a more holistic understanding of the concept of ecological coherence.

Management measures may also protect additional habitats and species beyond the features for which a MPA was selected. This form of ‘incidental’ protection can occur when management zones encompass larger areas of the seabed than the extent of target features alone. For example, a patchy target habitat may occur in a complex mosaic with another habitat, making it impractical to manage the target habitat in isolation, or a management zone could incorporate buffers around a target habitat, encompassing other habitats in the immediately adjacent area. Once management measures are more widely implemented, the contribution of these additional cases of protection could be incorporated into assessments of whether a network is ecologically coherent.

Annex A: MPA features for network assessment

The tables below show the Northern Ireland PMF and pMCZ features considered in this assessment[52]. Some of these features are of specific conservation importance to Northern Ireland only, whilst others are of international conservation importance, e.g. OSPAR threatened and/or declining species and habitats[53]. A number of the features of conservation importance to Northern Ireland occur in the wider biogeographic region and are included on the UK MPA network feature list[54]. These could therefore be assessed at the wider biogeographic scale (results presented in Annex C) but the data available for these features may be incomplete or patchy.

Habitats

Habitat name	Source list
High energy littoral rock*	EUNIS level 3
Moderate energy littoral rock*	EUNIS level 3
Low energy littoral rock*	EUNIS level 3
Littoral coarse sediment*	EUNIS level 3
Littoral sand and muddy sand*	EUNIS level 3
Littoral mud*	EUNIS level 3
Littoral mixed sediments*	EUNIS level 3
Coastal saltmarshes and saline reedbeds*	EUNIS level 3
Littoral sediments dominated by aquatic angiosperms*	EUNIS level 3
Littoral biogenic reefs*	EUNIS level 3
High energy infralittoral rock*	EUNIS level 3
Moderate energy infralittoral rock*	EUNIS level 3
Low energy infralittoral rock*	EUNIS level 3
High energy circalittoral rock*	EUNIS level 3
Moderate energy circalittoral rock*	EUNIS level 3
Low energy circalittoral rock*	EUNIS level 3 + pMCZ habitat
Sublittoral coarse sediment*	EUNIS level 3
Sublittoral sand*	EUNIS level 3 + pMCZ habitat
Sublittoral mud*	EUNIS level 3 + pMCZ habitat
Sublittoral mixed sediments*	EUNIS level 3 + pMCZ habitat
Sublittoral macrophyte-dominated sediment*	EUNIS level 3
Sublittoral biogenic reefs*	EUNIS level 3 + pMCZ habitat
Deep-sea rock and artificial hard substrata*	EUNIS level 3 (+ pMCZ habitat at EUNIS level 2)
Deep-sea mixed substrata*	EUNIS level 3 (+ pMCZ habitat at EUNIS level 2)
Blue mussel beds (intertidal)[55] *	PMF habitat 'afforded protection'
Blue mussel beds (subtidal) *	pMCZ component habitat

[52] These are listed in the Justification report for selection of proposed Marine Conservation Zones (pMCZ) features available here: https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20selection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%29%20features_0.pdf

[53] Available at: https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats

[54] Available at: http://jncc.defra.gov.uk/page-7438

[55] Intertidal and subtidal *Blue mussel beds* were assessed separately at the Northern Ireland inshore region scale. However, they were aggregated at the CP2 biogeographic region scale because the intertidal and subtidal types are not considered separately on the UK MPA network features list, and are not considered separate priority features for designation by other Administrations.

Habitat name	Source list
Brittlestar beds~	pMCZ component habitat
Coastal saltmarsh	PMF habitat 'afforded protection'
Cold water coral reefs*	pMCZ component habitat
Estuarine rocky habitats*	pMCZ component habitat
Fragile sponge and anthozoan communities on subtidal rocky habitats*	PMF habitat 'afforded protection'
Horse mussel (*Modiolus modiolus*) beds*	pMCZ component habitat
Intertidal mudflats	PMF habitat 'afforded protection'
Intertidal under-boulder communities*	PMF habitat 'afforded protection'
Littoral chalk communities*	PMF habitat 'afforded protection'
Maerl beds*	PMF habitat 'afforded protection'
Mud habitats in deep water*	pMCZ component habitat
Native oyster (*Ostrea edulis*) beds*	pMCZ component habitat
Philine aperta and *Virgularia* mirabilis on infralittoral mud	MCZ designated habitat
Sabellaria alveolata reefs*	PMF habitat 'afforded protection'
Saline lagoons	PMF habitat 'afforded protection'
Seagrass (*Zostera*) beds*	PMF habitat 'afforded protection'
Sea-pen and burrowing megafauna communities*	pMCZ component habitat
Sheltered muddy gravels*	PMF habitat 'afforded protection'
Subtidal chalk*	PMF habitat 'afforded protection'
Tide-swept channels*	PMF habitat 'afforded protection' + pMCZ component habitat

* UK MPA network feature to be assessed at the biogeographic region scale
~ Data available for feature to be assessed at the biogeographic region scale, but not a UK MPA network feature. A lower replication target of two rather than three protected replicates was assessed for this feature at the biogeographic scale.

Low/limited mobility species

Scientific name	Group / Common name	Source list
Ascophyllum nodosum ecad var mackayi (*mackaii)*	Alga – Brown	PMF LLMS 'afforded protection'
Carpomitra costata	Alga – Brown	PMF LLMS 'afforded protection'
*Desmarestia dresnayi**	Alga – Brown	PMF LLMS 'afforded protection'
Atractophora hypnoides	Alga – Red	PMF LLMS 'afforded protection'
*Cruoria cruoriaeformis**	Alga – Red	PMF LLMS 'afforded protection'
*Phymatolithon calcareum**	Alga - Red	PMF LLMS 'afforded protection'
Schmitzia hiscockiana	Alga – Red	PMF LLMS 'afforded protection'
Schmitzia neapolitana	Alga – Red	PMF LLMS 'afforded protection'
Stenogramme interrupta	Alga – Red	PMF LLMS 'afforded protection'
Sabellaria alveolata	Annelida	PMF LLMS 'afforded protection'
Bugula turbinata	Bryozoa – an erect bryozoan	PMF LLMS 'afforded protection'
Pentapora foliacea	Bryozoa – Ross coral/Potato crisp bryozoan	PMF LLMS 'afforded protection'
Alcyonium hibernicum	Cnidaria – Soft coral	PMF LLMS 'afforded protection'
*Arachnanthus sarsi**	Cnidaria – Anemone	PMF LLMS 'afforded protection'
Aureliania heterocera	Cnidaria – Emperor/Imperial anemone	PMF LLMS 'afforded protection'
Caryophyllia inornata	Cnidaria – Cup coral	PMF LLMS 'afforded protection'
Caryophyllia smithii	Cnidaria – Cup coral	PMF LLMS 'afforded protection'

Scientific name	Group / Common name	Source list
Diphasia alata	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
Diphasia nigra	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
*Edwardsia timida**	Cnidaria – Anemone	PMF LLMS 'afforded protection'
Halecium plumosum	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
*Haliclystus auricula**	Cnidaria – Stalked jellyfish	PMF LLMS 'afforded protection'
Lytocarpia myriophyllum	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
Parazoanthus anguicomus	Cnidaria – Anemone	PMF LLMS 'afforded protection'
*Parazoanthus axinellae**	Cnidaria – Yellow trumpet anemone	PMF LLMS 'afforded protection'
Polyplumaria flabellata	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
Stomphia coccinea	Cnidaria –Anemone	PMF LLMS 'afforded protection'
Tamarisca tamarisca	Cnidaria – Hydroid	PMF LLMS 'afforded protection'
*Atelecyclus rotundatus**	Crustacea – Circular crab	PMF LLMS 'afforded protection'
Cestopagurus timidus	Crustacea – Hermit crab	PMF LLMS 'afforded protection'
Corystes cassivelaunus	Crustacea – Masked crab	PMF LLMS 'afforded protection'
Homarus gammarus	Crustacea – European lobster	PMF LLMS 'afforded protection'
Inachus leptochirus	Crustacea – Spider crab	PMF LLMS 'afforded protection'
*Munida rugosa**	Crustacea – Squat lobster	PMF LLMS 'afforded protection'
*Palinurus elephas**	Crustacea – Spiny lobster	PMF LLMS 'afforded protection'
*Anseropoda placenta**	Echinodermata – Goosefoot starfish	PMF LLMS 'afforded protection'
Antedon petasus	Echinodermata – Feather star	PMF LLMS 'afforded protection'
Asterina phylactica	Echinodermata – Cushion star	PMF LLMS 'afforded protection'
Asteropecten irregularis	Echinodermata – Starfish	PMF LLMS 'afforded protection'
*Labidoplax media**	Echinodermata – Sea cucumber	PMF LLMS 'afforded protection'
Leptasterias muelleri	Echinodermata – Starfish	PMF LLMS 'afforded protection'
Leptosynapta bergensis	Echinodermata – Sea cucumber	PMF LLMS 'afforded protection'
*Paracucumaria hyndmani**	Echinodermata – Hyndman's sea cucumber	PMF LLMS 'afforded protection'
Porania pulvillus	Echinodermata – Cushion star	PMF LLMS 'afforded protection'
Solaster endeca	Echinodermata – Sunstar	PMF LLMS 'afforded protection'
*Thyonidium drummondi**	Echinodermata – Sea cucumber	PMF LLMS 'afforded protection'
Glossobalanus sarniensis	Hemichordata – Acorn worm	PMF LLMS 'afforded protection'
Aequipecten opercularis	Mollusca – Queen scallop	PMF LLMS 'afforded protection'
*Arctica islandica**	Mollusca – Ocean quahog	pMCZ LLMS
*Atrina fragilis**	Mollusca – Fan mussel	pMCZ LLMS
*Cerastoderma glaucum **	Mollusca – Brackish cockle	PMF LLMS 'afforded protection'
Chlamys varia	Mollusca – Variegated scallop	PMF LLMS 'afforded protection'
Crenella decussata	Mollusca – Bivalve mussel	PMF LLMS 'afforded protection'
Cumanotus beaumonti	Mollusca – Nudibranch	PMF LLMS 'afforded protection'
Cuthona concinna	Mollusca – Nudibranch	PMF LLMS 'afforded protection'
Erato voluta	Mollusca – Egg cowrie	PMF LLMS 'afforded protection'
Eubranchus doriae	Mollusca –Nudibranch	PMF LLMS 'afforded protection'
Palio dubia	Mollusca – Nudibranch	PMF LLMS 'afforded protection'

Scientific name	Group / Common name	Source list
Pecten maximus	Mollusca – King scallop	PMF LLMS 'afforded protection'
Thecacera pennigera	Mollusca – Nudibranch	PMF LLMS 'afforded protection'
Tonicella marmorea	Mollusca – Chiton	PMF LLMS 'afforded protection'
Amphilectus ovulum	Porifera – Sponge	PMF LLMS 'afforded protection'
Antho brattegardi	Porifera – Sponge	PMF LLMS 'afforded protection'
Axinella damicornis	Porifera – Sponge	PMF LLMS 'afforded protection'
Axinella dissimilis	Porifera – Sponge	PMF LLMS 'afforded protection'
Biemna variantia	Porifera – Sponge	PMF LLMS 'afforded protection'
Clathria barleei	Porifera – Sponge	PMF LLMS 'afforded protection'
Eurypon coronula	Porifera – Sponge	PMF LLMS 'afforded protection'
Hymedesmia cohesibacilla	Porifera – Sponge	PMF LLMS 'afforded protection'
Hymedesmia rathlinia	Porifera – Sponge	PMF LLMS 'afforded protection'
Hymerhabdia typica	Porifera – Sponge	PMF LLMS 'afforded protection'
Iophon hyndmani	Porifera – Sponge	PMF LLMS 'afforded protection'
Lissodendoryx jenjonesae	Porifera – Sponge	PMF LLMS 'afforded protection'
Microciona elliptichela	Porifera – Sponge	PMF LLMS 'afforded protection'
Mycale cf. contarenii	Porifera – Sponge	PMF LLMS 'afforded protection'
Mycale lingua	Porifera – Sponge	PMF LLMS 'afforded protection'
Mycale similaris	Porifera – Sponge	PMF LLMS 'afforded protection'
Myxilla cf. rosacea	Porifera – Sponge	PMF LLMS 'afforded protection'
Plocamiancora arndti	Porifera – Sponge	PMF LLMS 'afforded protection'
Pyura microcosmus	Porifera – Sponge	PMF LLMS 'afforded protection'
Spanioplon armaturum	Porifera – Sponge	PMF LLMS 'afforded protection'
Spongionella pulchella	Porifera – Sponge	PMF LLMS 'afforded protection'
Stelletta grubii	Porifera – Sponge	PMF LLMS 'afforded protection'
Stryphnus ponderosus	Porifera – Sponge	PMF LLMS 'afforded protection'
Tethya hibernica	Porifera – Sponge	PMF LLMS 'afforded protection'
Archidistoma aggregatum	Tunicata – Sea squirt	PMF LLMS 'afforded protection'
Boltenia echinata	Tunicata – Sea squirt	PMF LLMS 'afforded protection'
Diazona violacea	Tunicata – Football sea squirt	PMF LLMS 'afforded protection'
*Pycnoclavella stolonialis**	Tunicata – Sea squirt	PMF LLMS 'afforded protection'
Synoicum incrustatum	Tunicata – Sea squirt	PMF LLMS 'afforded protection'

* UK MPA network feature to be assessed at the biogeographic region scale

Highly mobile species

Scientific name	Common name	Source list
*Dipturus batis**	Common skate	pMCZ highly mobile species
Cepphus grylle ˜	Black guillemot	pMCZ highly mobile species
*Phocoena phocoena**	Harbour porpoise	PMF highly mobile species 'afforded protection'

* UK MPA network feature to be assessed at the biogeographic region scale

˜ Data available for feature to be assessed at the biogeographic region scale, but not a UK MPA network feature. A lower replication target of two rather than three protected replicates was assessed for this feature at the biogeographic scale.

Geological/geomorphological features

Feature name	Source list
Glacial process features	pMCZ geological/geomorphological feature
Marine process features	pMCZ geological/geomorphological feature
Mass movement features	pMCZ geological/geomorphological feature
Features indicating past change in relative sea level	pMCZ geological/geomorphological feature
Geological process features	pMCZ geological/geomorphological feature
Seaward extension features	pMCZ geological/geomorphological feature

Annex B: Technical account of area calculations for assessing adequacy of subtidal broad-scale habitats

Three area parameters were used to calculate the percentage cover of each subtidal broad-scale habitat, and the percentage of each habitat protected by MPAs (relative to its total extent). These included the total areas of:

1. subtidal broad-scale habitats in the Northern Ireland inshore region, in each Charting Progress 2 (CP2) biogeographic region, and in the Northern Ireland inshore region divided by region (i.e. the Northern Ireland sections of each biogeographic region);
2. subtidal broad-scale habitats in MPAs in the Northern Ireland inshore region, in each biogeographic region, and in the Northern Ireland sections of each region.
3. the Northern Ireland inshore region, the Irish Sea and Minches & Western Scotland biogeographic regions, and the Northern Ireland sections of these regions.

The source of habitat data was a seabed broad-scale habitat map for the Irish Sea and Minches & Western Scotland biogeographic regions (see Section 3.4 above). This map was an integration of maps from field surveys and datasets modelling the distribution subtidal broad-scale habitats, including UKSeaMap 2016[56]. JNCC used the broad-scale habitat map to calculate habitat cover inside and outside of MPAs at the Northern Ireland inshore region and wider biogeographic scales. The 'Biozone' attribute of the UKSeaMap 2016 model was aggregated to create broad seabed depth bands (shallow and shelf biozones) which were merged into the broad-scale habitat map to further refine the broad-scale habitats by depth.

The broad-scale habitat map was imported into a SQL-Server database along with layers delineating the Northern Ireland inshore region, biogeographic reporting regions, MPA site boundaries (SACs, MCZs, NCMPAs and two Ramsar Sites) and subtidal Annex I feature extents for all Special Areas of Conservation. Manipulations of these spatial data and area calculations were undertaken in Microsoft SQL-Server Management Studio (2008 R2). Estimates of habitat area were calculated in square-kilometres with the map layers in Albers Equal Area Conic Projection.

Subtidal broad-scale habitat polygons in the broad-scale habitat map were divided using the limits of the Northern Ireland inshore region and the biogeographic regions to create an integrated map, with each habitat polygon attributed by administrative sea name (Northern Ireland inshore region versus other Administrations' waters), biogeographic region name and the area of the polygon. This map covered the full extent of subtidal habitats in the Irish Sea and Minches & Western Scotland biogeographic regions.

In a separate layer, the habitat polygons from the broad-scale habitat map were also divided by and clipped to MPA site boundaries and (for SACs only) to subtidal Annex I feature extents. This process created an integrated map of subtidal broad-scale habitats occurring within MPAs and contained the attribute data from all of the input layers. Each habitat polygon was attributed by administrative area name, biogeographic region name, MPA site name, MPA designation status, Annex I feature name (for SACs only) and the area of the polygon.

SQL scripts were written to resolve overlaps between the input layers (for example between MPAs or between Annex I features within a site) while maintaining their respective attributes

[56] JNCC (2017). UKSeaMap 2016: broad-scale habitat map for UK waters. Available online at http://jncc.defra.gov.uk/ukseamap

in the integrated output; this process prevented duplication within habitat area estimates but allowed area calculations at various scales. The integrated map of MPA habitats was then joined with a look-up table cataloguing the subtidal broad-scale habitats protected in MPAs (see Section 3.4 above), creating an attribute column to indicate whether the habitat found in a given site or Annex I feature was afforded protection. This join ensured that only those habitat polygons falling within a MPA and with 'protected' status could contribute to the total areas of protected habitat; those habitats within MPAs but not formally protected were excluded from final area totals.

Area data for all polygons in both subtidal broad-scale habitat layers were aggregated using SQL database queries to estimate total habitat cover and total area of habitat protected in MPAs in the Northern Ireland inshore region and in the wider biogeographic regions. The total areas of the Northern Ireland inshore region, the biogeographic regions and Northern Ireland sections of the biogeographic regions were calculated from their respective input layers. Where habitat data comprised a mosaic of subtidal broad-scale habitats the areas were divided by the number of component habitats resulting in area values that could be attributed to each habitat.

Annex C: Detailed results of the assessment at the biogeographic scale and the link to the Northern Ireland inshore region

The MPA network in the wider Irish Sea and Minches & Western Scotland CP2 regions was assessed to understand what is currently protected and to identify any potential shortfalls against the assessment criteria. This annex briefly describes the existing protection of features and possible overall shortfalls at the biogeographic region scale, followed by a summary of the wider network gaps relevant to Northern Ireland. The results provide an indication of how the Northern Ireland MPA network could potentially contribute to furthering an ecologically coherent network at the broader biogeographic scale in the future.

An analysis of the Northern Ireland inshore region divided by the two biogeographic regions was also undertaken to understand Northern Ireland's existing contribution to the wider MPA network and this is presented in Annex D. This additional analysis was necessary to determine how Northern Ireland could potentially address the shortfalls for the biogeographic scale presented in this annex.

AC.1 Broad-scale habitats at the biogeographic region scale

Intertidal broad-scale habitats were assessed against the criteria for representativity (criteria i) and replication (criteria ii). Subtidal broad-scale habitats were assessed against the minimum criteria of representativity, replication and adequacy (criteria i, ii and iv).

All broad-scale habitats present in the Irish Sea and Minches & Western Scotland biogeographic regions are represented in the UK MPA network (Table AC.1). All broad-scale habitats were also replicated in MPAs in the Irish Sea region and the majority (21 out of 24) are replicated in the Minches & Western Scotland region. Deep-sea habitats are not currently known to occur in the Irish Sea region. Only one example of *Deep-sea rock and artificial hard substrata* is currently known from the Minches & Western Scotland region and therefore replication of this feature is not possible. After reviewing these results, two broad-scale habitats were considered to have a shortfall in their replication in the Minches & Western Scotland region (*Littoral mixed sediments* and *Deep-sea mixed substrata*), but neither of these features could gain further protection in the Northern Ireland inshore region.

Shortfalls in the adequacy of habitat coverage in MPAs were considered relevant to Northern Ireland if any areas of habitat in the Northern Ireland inshore region (where not already protected) could be afforded protection to help address shortfalls at the wider biogeographic region scale. However, if the habitat was already adequately (>10%) protected in the Northern Ireland inshore region these cases were not considered a gap for Northern Ireland.

In the Irish Sea region, shortfalls in the adequacy of protection were identified for *Moderate energy circalittoral rock*, *Low energy circalittoral rock*, *Sublittoral coarse sediment* and *Sublittoral mixed sediments* (Table AC.1). Three of these habitats also show a shortfall in the Northern Ireland inshore section of the Irish Sea region (Table AD.1, Annex D), and these are marked as MPA network gaps for Northern Ireland in Table AC.1.The proportion of *Sublittoral mud* protected in the Irish Sea region is just less than 10% but as the shortfall (of 0.5%) is probably within the margin of error of the adequacy analysis, this was not identified as a MPA network gap for Northern Ireland at the biogeographic scale.

In the Minches & Western Scotland region, shortfalls in the adequacy of protection were identified for *High energy infralittoral rock*, *Moderate energy infralittoral rock*, *Low energy*

infralittoral rock, *High energy circalittoral rock*, *Low energy circalittoral rock*, *Sublittoral coarse sediment*, *Sublittoral sand*, *Sublittoral mud* and *Sublittoral mixed sediments* (Table AC.1). For six of these habitats (all five rock habitats and *Sublittoral mud*) very minimal or no known extent is known in the Northern Ireland inshore region. However, Northern Ireland could make a contribution to the shortfall in the protection of *Sublittoral coarse sediment* in the wider region (Table AD.1, Annex D).

Table AC.1. Assessment of broad-scale habitat protection against the representativity, replication and adequacy criteria at the biogeographic region scale. The final column shows cases where a shortfall in the wider region could be addressed (partially or completely) by further protection of the habitat in the Northern Ireland inshore region. For shortfalls in the adequacy of protection, the final column is "Yes" if there is a gap at the wider biogeographic region scale and <10% of the habitat is protected in existing MPAs in the Northern Ireland inshore region. The percentage (by area) of habitat protected is only provided for those habitats that have not met the 10% adequacy level. The adequacy of intertidal (littoral) and deep-sea broad-scale habitats was not assessed (and hence marked "N/A").

Broad-scale habitat	**Represented?**	**Replicated?** (>1 replicate)	**10% area target met?**	**MPA network gap for NI?**
Irish Sea region				
High energy littoral rock	Y	Y	N/A	No
Moderate energy littoral rock	Y	Y	N/A	No
Low energy littoral rock	Y	Y	N/A	No
Littoral coarse sediment	Y	Y	N/A	No
Littoral sand and muddy sand	Y	Y	N/A	No
Littoral mud	Y	Y	N/A	No
Littoral mixed sediments	Y	Y	N/A	No
Coastal saltmarshes and saline reed beds	Y	Y	N/A	No
Littoral sediments dominated by aquatic angiosperms	Y	Y	N/A	No
Littoral biogenic reefs	Y	Y	N/A	No
High energy infralittoral rock	Y	Y	Y	No
Moderate energy infralittoral rock	Y	Y	Y	No
Low energy infralittoral rock	Y	Y	Y	No
High energy circalittoral rock	Y	Y	Y	No
Moderate energy circalittoral rock	Y	Y	N - 6.7%	Yes
Low energy circalittoral rock	Y	Y	N - 0.5%	Yes
Sublittoral coarse sediment	Y	Y	N - 6.2%	Yes
Sublittoral sand	Y	Y	Y	No
Sublittoral mud	Y	Y	N	No
Sublittoral mixed sediments	Y	Y	N	No
Sublittoral macrophyte-dominated sediment	Y	Y	Y	No
Sublittoral biogenic reefs	Y	Y	Y	No
Deep-sea rock and artificial hard substrata	N	N	N/A	No
Deep-sea mixed substrata	N	N	N/A	No

Broad-scale habitat	Represented?	Replicated? (>1 replicate)	10% area target met?	MPA network gap for NI?
Minches & Western Scotland region				
High energy littoral rock	Y	Y	N/A	No
Moderate energy littoral rock	Y	Y	N/A	No
Low energy littoral rock	Y	Y	N/A	No
Littoral coarse sediment	Y	Y	N/A	No
Littoral sand and muddy sand	Y	Y	N/A	No
Littoral mud	Y	Y	N/A	No
Littoral mixed sediments	Y	N	N/A	No
Coastal saltmarshes and saline reedbeds	Y	Y	N/A	No
Littoral sediments dominated by aquatic angiosperms	Y	Y	N/A	No
Littoral biogenic reefs	Y	Y	N/A	No
High energy infralittoral rock	Y	Y	N	No
Moderate energy infralittoral rock	Y	Y	N	No
Low energy infralittoral rock	Y	Y	N	No
High energy circalittoral rock	Y	Y	N	No
Moderate energy circalittoral rock	Y	Y	Y	No
Low energy circalittoral rock	Y	Y	N	No
Sublittoral coarse sediment	Y	Y	N - 1.2%	Yes
Sublittoral sand	Y	Y	N	No
Sublittoral mud	Y	Y	N	No
Sublittoral mixed sediments	Y	Y	N	No
Sublittoral macrophyte-dominated sediment	Y	Y	Y	No
Sublittoral biogenic reefs	Y	Y	Y	No
Deep-sea rock and artificial hard substrata	Y	N	N/A	No
Deep-sea mixed substrata	Y	N	N/A	No

AC.2 PMF/pMCZ habitats at the biogeographic region scale

Northern Ireland PMF/pMCZ habitats were assessed against the minimum criteria of representativity (criteria i) and replication (criteria iii), with the results presented in Table AC.2, to identify any shortfalls for the wider Irish Sea and Minches & Western Scotland biogeographic regions. Four PMF/pMCZ habitats (*Coastal saltmarsh*, *Intertidal mudflats*, *Philine aperta and Virgularia mirabilis on infralittoral mud*, and *Saline lagoons*) could not be assessed at the wider region scale because no suitable data were available at this wider scale or because they are only listed features specific to Northern Ireland.

Any gaps in the representativity and/or replication for Northern Ireland were then identified where further protection of replicates occurring in the Northern Ireland inshore region would help to address shortfalls identified in the wider biogeographic region. Where two or more replicates were already protected in the Northern Ireland inshore region, any shortfalls identified at the wider region scale were not considered gaps for Northern Ireland.

For the Irish Sea region, 14 of the 17 PMF/pMCZ habitats assessed are represented and 12 are replicated in the UK MPA network. JNCC concluded that there are shortfalls in the representativity and replication for *Subtidal chalk* and Native Oyster (*Ostrea edulis)* beds, and a shortfall in replication only for *Littoral chalk communities* at the wider biogeographic scale. However, none of these shortfalls are considered gaps for Northern Ireland. Two replicates of *Littoral chalk communities* are already protected in MPAs in the Northern Ireland section of the Irish Sea region. Furthermore, there are no records of *Subtidal chalk* and Native Oyster (*Ostrea edulis)* beds in this part of the Northern Ireland inshore region.

In the Minches & Western Scotland region, 14 PMF/pMCZ habitats are represented and 10 are replicated in MPAs. JNCC concluded that there is a shortfall in replication for Native Oyster (*Ostrea edulis)* beds at the wider biogeographic scale. This shortfall is also considered an MPA network gap in the Northern Ireland section of the Minches and Western Scotland region (Table AC.2) and at the overall Northern Ireland inshore region scale (see Section 5.2). Protecting further replicates of this habitat in the Northern Ireland section of the Minches & Western Scotland region would therefore close the gap in the Northern Ireland inshore region and help to reduce the shortfall in the wider UK MPA network (see Section 7.2).

Table AC.2. Assessing protection of Northern Ireland PMF/pMCZ habitats against representativity and replication criteria at the biogeographic region scale. The final column shows cases where a shortfall in the wider region could be reduced by further protection of the habitat in the Northern Ireland inshore region.

PMF and pMCZ habitat	Represented	Replicated? (>2 replicates)[57]	MPA network gap for NI?
Irish Sea region			
Blue mussel beds	Y	Y	No
Brittlestar beds	Y	Y	No
Cold water coral reefs	N	N	No
Estuarine rocky habitats	Y	Y	No
Fragile sponge and anthozoan communities on subtidal rocky habitats	Y	N	No
Horse mussel (*Modiolus modiolus*) beds	Y	Y	No
Intertidal under-boulder communities	Y	Y	No
Littoral chalk communities	Y	N	No
Maerl beds	Y	Y	No
Mud habitats in deep water	Y	Y	No
Native oyster (*Ostrea edulis*) beds	N	N	No
Sabellaria alveolata reefs	Y	Y	No
Seagrass (*Zostera*) beds	Y	Y	No
Sea-pen and burrowing megafauna communities	Y	Y	No
Sheltered muddy gravels	Y	Y	No
Subtidal chalk	N	N	No
Tide-swept channels	Y	Y	No
Minches & Western Scotland region			
Blue mussel beds	Y	Y	No
Brittlestar beds	Y	Y	No
Cold water coral reefs	Y	N	No
Estuarine rocky habitats	N	N	No
Fragile sponge and anthozoan communities on subtidal rocky habitats	Y	Y	No
Horse mussel (*Modiolus modiolus*) beds	Y	Y	No
Intertidal under-boulder communities	Y	N	No
Littoral chalk communities	Y	N	No
Maerl beds	Y	Y	No
Mud habitats in deep water	Y	Y	No
Native oyster (*Ostrea edulis*) beds	Y	N	Yes
Sabellaria alveolata reefs	N	N	No
Seagrass (*Zostera*) beds	Y	Y	No
Sea-pen and burrowing megafauna communities	Y	Y	No

[57] >2 replicates required except for *Brittlestar beds*, which is not on the UK MPA network features list and therefore was assessed for >1 replicate in the wider region.

PMF and pMCZ habitat	Represented	Replicated? (>2 replicates)[58]	MPA network gap for NI?
Sheltered muddy gravels	N	N	No
Subtidal chalk	Y	Y	No
Tide-swept channels	Y	Y	No

AC.3 Species at the biogeographic region scale

Northern Ireland PMF/pMCZ species were assessed against the minimum criteria for representativity (criteria i) and replication (criteria iii), with the results presented in Table AC.3, to identify any shortfalls for the wider Irish Sea and Minches & Western Scotland biogeographic regions. Many PMF/pMCZ species could not be assessed at the wider scale since they are only listed features specific to Northern Ireland and therefore no suitable data are available on their protection in MPAs outside of the Northern Ireland inshore region.

Any gaps in the representativity and/or replication for Northern Ireland were then identified where further protection of examples occurring in the Northern Ireland inshore region would help to address any shortfalls identified at the overall biogeographic region scale. Where two or more replicates were already protected in the Northern Ireland section of the wider region, any shortfalls identified at the wider region scale were not considered gaps for Northern Ireland.

For the Irish Sea region, 19 of the 21 PMF/pMCZ species assessed are represented and four are replicated in the UK MPA network. After reviewing these results JNCC concluded that there are 14 replication shortfalls for PMF/pMCZ species at the biogeographic scale. Eight of these shortfalls are also considered MPA network gaps for Northern Ireland (Table AC.3). Protecting further replicates of these species in MPAs in the Northern Ireland section would help to address shortfalls in the wider UK MPA network for the region.

For the Minches & Western Scotland region, 17 of the 21 PMF/pMCZ species are represented and three are replicated in the UK MPA network. JNCC concluded that there are 17 shortfalls for PMF/pMCZ species at the biogeographic scale, including shortfalls in the representativity for *Desmarestia dresnayi*, *Edwardsia timida*, *Paracucumaria hyndmani*, and *Thyonidium drummondi*. Three of these shortfalls are also considered MPA network gaps for Northern Ireland (Table AC.3). Protecting further replicates of these species in MPAs in the Northern Ireland section would help to address shortfalls in the wider UK MPA network in the Minches & Western Scotland region.

Several of the species gaps identified at the biogeographic scale correspond to a gap in the replication for the Northern Ireland inshore region as a whole (see Section 5.2). Therefore, protecting further replicates of these species in the Northern Ireland inshore region has the potential to address gaps in both the Northern Ireland and shortfalls in wider UK MPA networks (see Section 7.2).

[58] >2 replicates required except for *Brittlestar beds*, which is not on the UK MPA network features list and therefore was assessed for >1 replicate in the wider region.

Table AC.3. Assessing protection of Northern Ireland PMF/pMCZ species against representativity and replication criteria at the biogeographic region level. The final column shows cases where a shortfall in the wider region could be reduced or fully addressed by further protection of the species in the Northern Ireland inshore region.

PMF and pMCZ species	Represented	Replicated? (>2 replicates)[59]	MPA network gap for NI in biogeographic region?
Irish Sea region			
Anseropoda placenta	Y	N	Yes
Arachnanthus sarsi	N	N	No
Arctica islandica	Y	Y	No
Atelecyclus rotundatus	Y	N	Yes
Atrina fragilis	N	N	No
Cepphus grylle	Y	N	Yes
Cerastoderma glaucum	Y	N	No
Cruoria cruoriaeformis	Y	N	No
Desmarestia dresnayi	Y	N	No
Dipturus batis	Y	N	Yes
Edwardsia timida	Y	N	No
Haliclystus auricula	Y	Y	No
Labidoplax media	Y	N	Yes
Munida rugosa	Y	N	Yes
Palinurus elephas	Y	N	No
Paracucumaria hyndmani	Y	N	Yes
Parazoanthus axinellae	Y	N	No
Phocoena phocoena	Y	Y	No
Phymatolithon calcareum	Y	Y	No
Pycnoclavella stolonialis	Y	N	Yes
Thyonidium drummondi	Y	N	No
Minches & Western Scotland region			
Anseropoda placenta	Y	N	Yes
Arachnanthus sarsi	Y	N	No
Arctica islandica	Y	Y	No
Atelecyclus rotundatus	Y	N	No
Atrina fragilis	Y	N	No
Cepphus grylle	Y	Y	No
Cerastoderma glaucum	Y	N	No
Cruoria cruoriaeformis	Y	N	No
Desmarestia dresnayi	N	N	No
Dipturus batis	Y	N	Yes
Edwardsia timida	N	N	No

[59] >2 replicates required except for *Cepphus grylle*, which is not on the UK MPA network features list and therefore was assessed for >1 replicate in the CP2 region.

PMF and pMCZ species	Represented	Replicated? (>2 replicates)[60]	MPA network gap for NI?
Haliclystus auricula	Y	N	No
Labidoplax media	Y	N	No
Munida rugosa	Y	N	No
Palinurus elephas	Y	N	Yes
Paracucumaria hyndmani	N	N	No
Parazoanthus axinellae	Y	N	No
Phocoena phocoena	Y	N	No
Phymatolithon calcareum	Y	Y	No
Pycnoclavella stolonialis	Y	N	No
Thyonidium drummondi	N	N	No

AC.4 Connectivity of MPAs at the biogeographic region scale

A high-level spatial assessment of the distance between MPAs protecting similar broad habitat types[61] showed that these protected habitats are generally well connected across the Irish Sea region and Minches & Western Scotland region (Figure AC.1). However, some gaps in the connectivity remain for all the broad habitat types. The gap for *Sublittoral sediments* is noteworthy because large areas of unprotected sediment are thought to be present in the parts of the Irish Sea region and Minches & Western Scotland region showing gaps in connectivity. *Infralittoral rock* and *Circalittoral rock* habitats are scarce in the parts of the regions where connectivity gaps occur although some options are likely to exist to reduce the connectivity gaps if more of these habitats were protected. The apparent gap in connectivity for *Infralittoral rock* in the centre of the Irish Sea region is a consequence of its very limited extent in this part of the region, so this is a naturally occurring gap.

[60] >2 replicates required except for *Cepphus grylle*, which is not listed as a priority feature for designation by all other administrations and therefore was assessed for >1 replicate in the biogeographic region.
[61] Broad habitat type is equivalent to the current (2007) level 2 in the EUNIS habitat classification

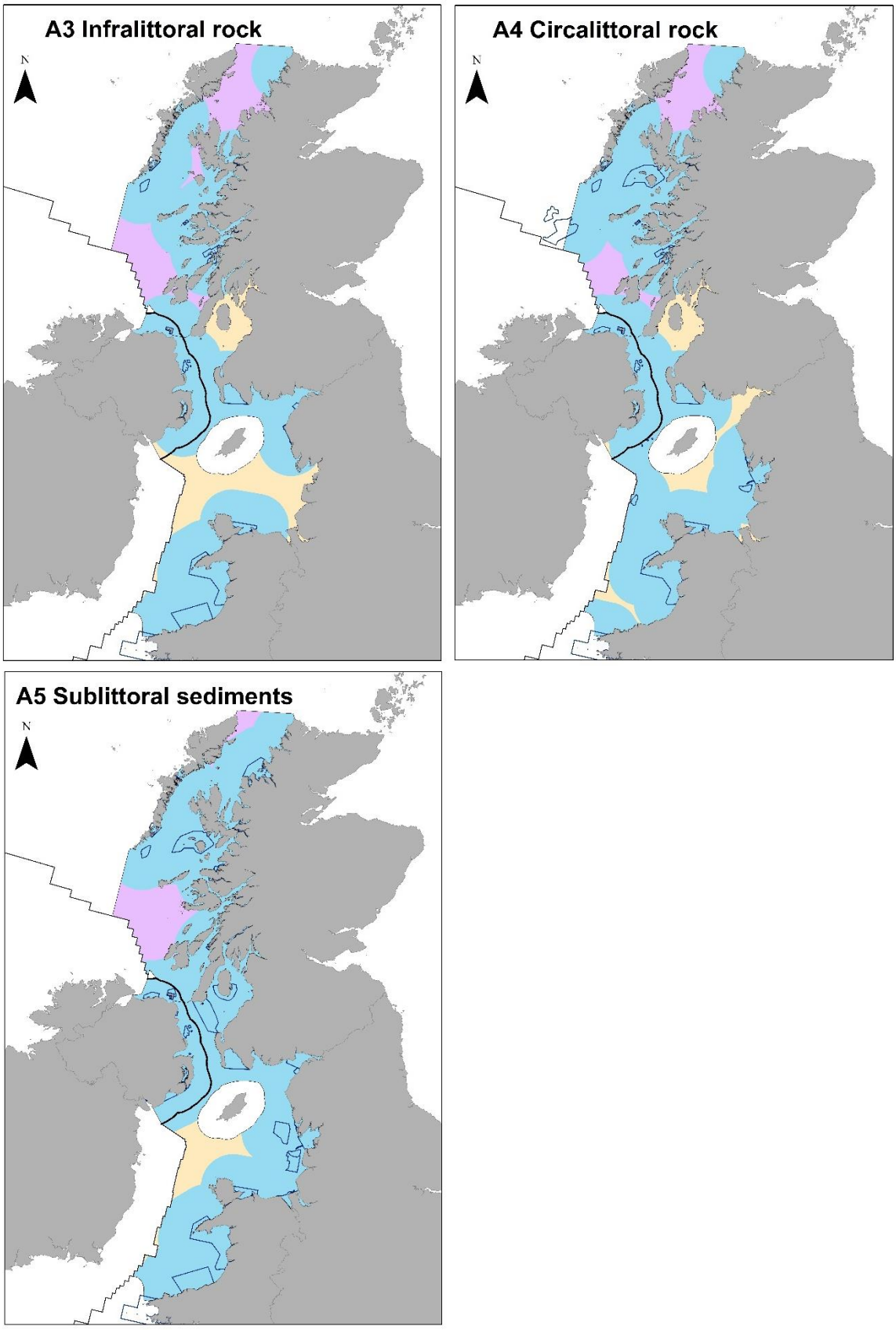


Figure AC.1. Connectivity between MPAs protecting the same broad habitat types. Blue areas depict the 40 km buffers around the MPAs in which the habitat is protected. Purple and orange areas demonstrate the parts of the Minches & Western Scotland and Irish Sea regions (respectively) where the protection these habitats may not be well connected.

Annex D: Assessment of the Northern Ireland MPA network split by biogeographic region

An assessment of the Northern Ireland inshore region divided into the two biogeographic regions (Irish Sea and Minches & Western Scotland regions) was undertaken to:

- Provide supplementary information on the contribution of Northern Ireland MPAs to the MPA network at the wider biogeographic scale, and thus towards the policy objective of an ecologically coherent MPA network in UK waters; *and*
- To inform the process of identifying opportunities for Northern Ireland to help address shortfalls at the wider biogeographic scale, as outlined in Section 6 and Annex C.

MPA network gaps were not identified at this 'local' scale *per se* – the results were used to decide on the relevance of wider biogeographic region-scale shortfalls to the Northern Ireland MPA network. This scale of assessment enabled JNCC and DAERA to determine whether Northern Ireland could potentially contribute further replicates towards any shortfalls in representativity and replication at the biogeographic region scale. This 'local' assessment also enabled shortfalls in adequacy of the area protected at the biogeographic region-scale to be prioritised in a Northern Ireland context, according to whether subtidal broad-scale habitats had already achieved >10% protection (by area) in the Northern Ireland inshore sections of the two biogeographic regions.

AD.1 Broad-scale habitats

For the Irish Sea region, 22 of the 24 broad-scale habitats assessed are represented, with the majority replicated in Northern Ireland MPAs. In the Minches & Western Scotland region, 18 of the 24 broad-scale habitats are represented and 12 are replicated in Northern Ireland MPAs.

For the Irish Sea region, the proportions of *Moderate energy infralittoral rock*, *Moderate energy circalittoral rock, Low energy circalittoral rock, Sublittoral coarse sediment* and *Sublittoral mud* habitats protected in MPAs are much less than 10% (Table AD.1). The proportions of *Sublittoral sand* and *Sublittoral mixed sediments* protected are very close to 10%, with the shortfalls (of 0.2% and 0.1%, respectively) probably well within the margin of error of the adequacy analysis.

For the Minches & Western Scotland region, the proportion of *Sublittoral coarse sediment* protected in MPAs is much less than 10% (Table AD.1), corresponding to gaps for this habitat at the overall Northern Ireland inshore region scale (Section 5.1.2) and a shortfall at the wider biogeographic region scale (Section 6.1). *Low energy circalittoral rock* protected in the Northern Ireland section of the Minches & Western Scotland region was minimal, but only a miniscule area (<1km^2) of this habitat is known to occur in this part of the Northern Ireland inshore region and therefore there are not thought to be any further viable patches for protection.

Some broad-scale habitats are not present, or have limited extent, at this refined scale of the Northern Ireland inshore region. Deep-sea habitats are not known to occur in the Northern Ireland section of the Irish Sea region. The proportion of *Low energy circalittoral rock* protected by Northern Ireland in the Irish Sea region was minimal, but only a very small and fragmented area (>10km^2) of this habitat is known to occur in this part of the Northern Ireland inshore region; available data indicates there are no viable patches available for additional protection. *Sublittoral mud* and *Sublittoral biogenic reefs* have not been recorded in the Northern Ireland section of the Minches & Western Scotland region and, although a miniscule <1km^2 extent was found in the broad-scale map, no viable patches of *Low energy circalittoral rock* are known to occur in this part of the Northern Ireland inshore region. Only one example of each deep-

sea habitat is known in the Northern Ireland section of the Minches & Western Scotland region, and therefore replication in the MPA network is not possible.

Table AD.1. Representativity, replication and adequacy of broad-scale habitat protection for the Northern Ireland inshore region divided into Irish Sea and Minches & Western Scotland biogeographic regions. The percentage (by area) of habitat protected is provided for habitats that did not exceed 10%. The adequacy of intertidal (littoral) and deep-sea broad-scale habitats was not assessed (marked "N/A").

Broad-scale habitat	**Represented?**	**Replicated?** (>1 replicate)	**10% area target met?**
Northern Ireland section of the Irish Sea region			
High energy littoral rock	Y	Y	N/A
Moderate energy littoral rock	Y	Y	N/A
Low energy littoral rock	Y	Y	N/A
Littoral coarse sediment	Y	Y	N/A
Littoral sand and muddy sand	Y	Y	N/A
Littoral mud	Y	Y	N/A
Littoral mixed sediments	Y	N	N/A
Coastal saltmarshes and saline reed beds	Y	Y	N/A
Littoral sediments dominated by aquatic angiosperms	Y	Y	N/A
Littoral biogenic reefs	Y	Y	N/A
High energy infralittoral rock	Y	Y	Y
Moderate energy infralittoral rock	Y	Y	N - 6.8%
Low energy infralittoral rock	Y	N	N - 0.2%
High energy circalittoral rock	Y	Y	Y
Moderate energy circalittoral rock	Y	N	N - 2.5%
Low energy circalittoral rock	Y	N	N - 0.5%
Sublittoral coarse sediment	Y	Y	N - 0.4%
Sublittoral sand	Y	Y	N - 9.8%
Sublittoral mud	Y	Y	N - 4.3%
Sublittoral mixed sediments	Y	Y	N - 9.9%
Sublittoral macrophyte-dominated sediment	Y	Y	Y
Sublittoral biogenic reefs	Y	Y	Y
Deep-sea rock and artificial hard substrata	N	N	N/A
Deep-sea mixed substrata	N	N	N/A
Northern Ireland section of the Minches & Western Scotland			
High energy littoral rock	Y	Y	N/A
Moderate energy littoral rock	Y	Y	N/A
Low energy littoral rock	Y	Y	N/A
Littoral coarse sediment	Y	N	N/A
Littoral sand and muddy sand	N	N	N/A
Littoral mud	N	N	N/A
Littoral mixed sediments	N	N	N/A
Coastal saltmarshes and saline reed beds	Y	N	N/A

Broad-scale habitat	**Represented?**	**Replicated?** (>1 replicate)	**10% area target met?**
Littoral sediments dominated by aquatic angiosperms	Y	N	N/A
Littoral biogenic reefs	Y	N	N/A
High energy infralittoral rock	Y	Y	Y
Moderate energy infralittoral rock	Y	Y	Y
Low energy infralittoral rock	Y	Y	Y
High energy circalittoral rock	Y	Y	Y
Moderate energy circalittoral rock	Y	Y	Y
Low energy circalittoral rock	N	N	N - 0.0%
Sublittoral coarse sediment	Y	Y	N - 0.7%
Sublittoral sand	Y	Y	Y
Sublittoral mud	N	N	N/A
Sublittoral mixed sediments	Y	Y	Y
Sublittoral macrophyte-dominated sediment	Y	Y	Y
Sublittoral biogenic reefs	N	N	N/A
Deep-sea rock and artificial hard substrata	Y	N	N/A
Deep-sea mixed substrata	Y	N	N/A

AD.2 PMF/pMCZ habitat gaps at the biogeographic region scale

JNCC examined the representativity and replication of Northern Ireland PMF/pMCZ habitats in the MPA network in the Northern Ireland inshore section of each biogeographic region. For the Irish Sea region, 19 out of the 22 PMF/pMCZ habitats assessed are represented and nine are replicated (Table AD.2). For the Minches & Western Scotland region, 10 PMF/pMCZ habitats are represented and six are replicated.

Table AD.2. Representativity and replication of Northern Ireland PMF/pMCZ habitats protected in MPAs in the Northern Ireland inshore region split into the Irish Sea and Minches & Western Scotland biogeographic regions.

PMF and pMCZ habitat	Represented?	Replicated? (>1 replicate)
Northern Ireland section of the Irish Sea region		
Blue mussel beds (intertidal)	Y	Y
Blue mussel beds (subtidal)	Y	N
Brittlestar beds	Y	N
Coastal saltmarsh	Y	Y
Cold water coral reefs	N	N
Estuarine rocky habitats	Y	N
Fragile sponge and anthozoan communities on subtidal rocky habitats	Y	N
Horse mussel (*Modiolus modiolus*) beds	Y	N
Intertidal mudflats	Y	Y
Intertidal under-boulder communities	Y	Y
Littoral chalk communities	Y	Y
Maerl beds	Y	N
Mud habitats in deep water	Y	N
Native oyster (*Ostrea edulis*) beds	N	N
Philine aperta and *Virgularia mirabilis* on infralittoral mud	Y	N
Sabellaria alveolata reefs	Y	N
Saline lagoons	Y	Y
Seagrass (*Zostera*) beds	Y	Y
Sea-pen and burrowing megafauna communities	Y	Y
Sheltered muddy gravels	Y	N
Subtidal chalk	N	N
Tide-swept channels	Y	Y
Northern Ireland section of the Minches & Western Scotland region		
Blue mussel beds (intertidal)	Y	N
Blue mussel beds (subtidal)	N	N
Brittlestar beds	N	N
Coastal saltmarsh	Y	N
Cold water coral reefs	N	N
Estuarine rocky habitats	N	N
Fragile sponge and anthozoan communities on subtidal rocky habitats	Y	Y
Horse mussel (*Modiolus modiolus*) beds	N	N

PMF and pMCZ habitat	**Represented?**	**Replicated?** (>1 replicate)
Intertidal mudflats	N	N
Intertidal under-boulder communities	Y	Y
Littoral chalk communities	Y	Y
Maerl beds	Y	N
Mud habitats in deep water	N	N
Native oyster (*Ostrea edulis*) beds	N	N
Philine aperta and *Virgularia mirabilis* on infralittoral mud	N	N
Sabellaria alveolata reefs	N	N
Saline lagoons	Y	N
Seagrass (*Zostera*) beds	Y	Y
Sea-pen and burrowing megafauna communities	N	N
Sheltered muddy gravels	N	N
Subtidal chalk	Y	Y
Tide-swept channels	Y	Y

AD.3 Species habitat gaps at the biogeographic region scale

JNCC examined the representativity (criteria i) and replication of Northern Ireland PMF/pMCZ species (criteria iii) in the MPA network in the Northern Ireland inshore section of each biogeographic region (Table AD.3). For the Irish Sea region, 75 out of 93 PMF/pMCZ species are represented and 15 are replicated in MPAs. For the Minches & Western Scotland region, 71 are represented and 22 are replicated.

Table AD.3. Representativity and replication of Northern Ireland PMF/pMCZ species protected in MPAs in the Northern Ireland inshore region split into the Irish Sea and Minches & Western Scotland biogeographic regions.

PMF and pMCZ species	Represented?	Replicated? (>1 replicate)
Irish Sea region		
Aequipecten opercularis	Y	Y
Alcyonium hibernicum	N	N
Amphilectus ovulum	Y	N
Anseropoda placenta	Y	N
Antedon petasus	N	N
Antho brattegardi	Y	N
Arachnanthus sarsi	N	N
Archidistoma aggregatum	Y	N
Arctica islandica	Y	N
Ascophyllum nodosum ecad var mackayi (mackaii)	Y	N
Asterina phylactica	Y	N
Asteropecten irregularis	Y	N
Atelecyclus rotundatus	Y	N
Atractophora hypnoides	N	N
Atrina fragilis	N	N
Aureliania heterocera	Y	Y
Axinella damicornis	N	N
Axinella dissimilis	Y	N
Biemna variantia	Y	N
Boltenia echinata	Y	N
Bugula turbinata	Y	Y
Carpomitra costata	Y	N
Caryophyllia inornata	N	N
Caryophyllia smithii	Y	Y
Cepphus grylle	N	N
Cerastoderma glaucum	Y	N
Cestopagurus timidus	N	N
Chlamys varia	Y	N
Clathria barleei	Y	N
Corystes cassivelaunus	Y	N
Crenella decussata	Y	N
Cruoria cruoriaeformis	Y	N
Cumanotus beaumonti	Y	Y

PMF and pMCZ species	Represented?	Replicated? (>1 replicate)
Cuthona concinna	Y	N
Desmarestia dresnayi	Y	N
Diazona violacea	N	N
Diphasia alata	Y	N
Diphasia nigra	Y	N
Dipturus batis	Y	N
Edwardsia timida	Y	N
Erato voluta	N	N
Eubranchus doriae	N	N
Eurypon coronula	Y	N
Glossobalanus sarniensis	Y	N
Halecium plumosum	Y	Y
Haliclystus auricula	Y	Y
Homarus gammarus	Y	Y
Hymedesmia cohesibacilla	Y	N
Hymedesmia rathlinia	Y	N
Hymerhabdia typica	Y	N
Inachus leptochirus	Y	N
Iophon hyndmani	Y	Y
Labidoplax media	Y	N
Leptasterias muelleri	Y	Y
Leptosynapta bergensis	Y	N
Lissodendoryx jenjonesae	Y	N
Lytocarpia myriophyllum	Y	N
Microciona elliptichela	Y	N
Munida rugosa	Y	N
Mycale cf. contarenii	Y	N
Mycale lingua	N	N
Mycale similaris	Y	N
Myxilla cf. rosacea	Y	Y
Palinurus elephas	N	N
Palio dubia	Y	N
Paracucumaria hyndmani	Y	N
Parazoanthus anguicomus	Y	N
Parazoanthus axinellae	N	N
Pecten maximus	Y	Y
Pentapora foliacea	N	N
Phocoena phocoena	Y	N
Phymatolithon calcareum	Y	N
Plocamiancora arndti	Y	N
Polyplumaria flabellata	Y	N
Porania pulvillus	Y	N
Pycnoclavella stolonialis	Y	N
Pyura microcosmus	Y	N

PMF and pMCZ species	Represented?	Replicated? (>1 replicate)
Sabellaria alveolata	Y	N
Schmitzia hiscockiana	Y	N
Schmitzia neapolitana	Y	N
Solaster endeca	Y	N
Spanioplon armaturum	Y	N
Spongionella pulchella	Y	N
Stelletta grubii	N	N
Stenogramme interrupta	Y	Y
Stomphia coccinea	Y	N
Stryphnus ponderosus	N	N
Synoicum incrustatum	Y	N
Tamarisca tamarisca	Y	N
Tethya hibernica	Y	N
Thecacera pennigera	Y	Y
Thyonidium drummondi	Y	N
Tonicella marmorea	Y	N
Minches & Western Scotland region		
Aequipecten opercularis	Y	N
Alcyonium hibernicum	Y	N
Amphilectus ovulum	N	N
Anseropoda placenta	Y	N
Antedon petasus	Y	Y
Antho brattegardi	Y	N
Arachnanthus sarsi	Y	N
Archidistoma aggregatum	Y	N
Arctica islandica	N	N
Ascophyllum nodosum ecad var mackayi (mackaii)	N	N
Asterina phylactica	N	N
Asteropecten irregularis	Y	N
Atelecyclus rotundatus	Y	Y
Atractophora hypnoides	Y	N
Atrina fragilis	N	N
Aureliania heterocera	Y	N
Axinella damicornis	Y	Y
Axinella dissimilis	Y	Y
Biemna variantia	N	N
Boltenia echinata	Y	N
Bugula turbinata	Y	Y
Carpomitra costata	Y	N
Caryophyllia inornata	Y	N
Caryophyllia smithii	Y	Y
Cepphus grylle	Y	N

PMF and pMCZ species	Represented?	Replicated? (>1 replicate)
Cerastoderma glaucum	N	N
Cestopagurus timidus	Y	N
Chlamys varia	N	N
Clathria barleei	Y	N
Corystes cassivelaunus	Y	Y
Crenella decussata	N	N
Cruoria cruoriaeformis	Y	Y
Cumanotus beaumonti	Y	N
Cuthona concinna	Y	N
Desmarestia dresnayi	N	N
Diazona violacea	Y	N
Diphasia alata	Y	N
Diphasia nigra	Y	N
Dipturus batis	N	N
Edwardsia timida	N	N
Erato voluta	Y	N
Eubranchus doriae	Y	N
Eurypon coronula	N	N
Glossobalanus sarniensis	N	N
Halecium plumosum	Y	Y
Haliclystus auricula	Y	Y
Homarus gammarus	Y	Y
Hymedesmia cohesibacilla	Y	N
Hymedesmia rathlinia	Y	N
Hymerhabdia typica	Y	N
Inachus leptochirus	Y	N
Iophon hyndmani	Y	N
Labidoplax media	Y	N
Leptasterias muelleri	Y	Y
Leptosynapta bergensis	N	N
Lissodendoryx jenjonesae	Y	N
Lytocarpia myriophyllum	Y	N
Microciona elliptichela	Y	N
Munida rugosa	Y	Y
Mycale cf. contarenii	N	N
Mycale lingua	Y	N
Mycale similaris	N	N
Myxilla cf. rosacea	Y	Y
Palinurus elephas	Y	N
Palio dubia	Y	Y
Paracucumaria hyndmani	N	N
Parazoanthus anguicomus	Y	N
Parazoanthus axinellae	Y	N

PMF and pMCZ species	Represented?	Replicated? (>1 replicate)
Pecten maximus	Y	Y
Pentapora foliacea	Y	Y
Phocoena phocoena	Y	N
Phymatolithon calcareum	Y	Y
Plocamiancora arndti	Y	N
Polyplumaria flabellata	Y	N
Porania pulvillus	Y	N
Pycnoclavella stolonialis	Y	Y
Pyura microcosmus	Y	Y
Sabellaria alveolata	N	N
Schmitzia hiscockiana	Y	N
Schmitzia neapolitana	N	N
Solaster endeca	N	N
Spanioplon armaturum	Y	N
Spongionella pulchella	Y	N
Stelletta grubii	Y	N
Stenogramme interrupta	Y	N
Stomphia coccinea	Y	N
Stryphnus ponderosus	Y	N
Synoicum incrustatum	Y	Y
Tamarisca tamarisca	Y	N
Tethya hibernica	Y	N
Thecacera pennigera	Y	Y
Thyonidium drummondi	N	N
Tonicella marmorea	N	N

Annex E: Supplementary analyses to refine the MPA network criteria

JNCC undertook some exploratory analyses to explore how the MPA network criteria (set out in Section 2.1) could potentially be refined to improve our understanding of the Northern Ireland MPA network. JNCC examined whether the MPA network is likely to provide protection to the range of detailed biotopes likely to occur in the Northern Ireland inshore region. Since maps showing the distribution of biotopes are not available, JNCC used a proxy of the proportionate protection of broad scale habitats along the seabed depth gradient in the Northern Ireland inshore region and also a second proxy of the amount of protection afforded to subtidal broad-scale habitats between two seabed depth biozones (shallow and shelf seabed). Furthermore, the size of MPAs was assessed to consider the likely viability of MPAs as a further extension of the MPA network criteria. These rudimentary analyses provide a starting point for developing more refined methods of assessing ecological coherence in the future.

AE.1 Coverage of MPAs by seabed depth

JNCC assessed the areal coverage of MPAs in relation to depth bands, quantifying the relative protection of shallow versus deeper waters to assess the likelihood that MPAs are protecting the range of biodiversity in the Northern Ireland inshore region. Bathymetry was used as a rudimentary proxy for change in biotopes and species composition across seabed depths. Depth bands of 0-10m (coastal zone); 10-75m (shelf seas); 75-200m (deeper shelf seas); and >200m (slope/upper bathyal zone) were selected, following an approach used for the study of ecological coherence in the OSPAR MPA network[62]. Site boundaries[63] were overlaid onto EMODnet bathymetric data[64] (Figure AE.1) to calculate the percentage area of each depth band occurring within MPAs for each biogeographic region.

The seabed in the Northern Ireland inshore region is split evenly between the shallower depth bands (0-10m and 10-75m) and the deeper shelf waters (75-200m and >200m). At least one third of the area of each depth band is found within MPAs (Table AE.1), indicating likely good coverage of the potential range of biotopes occurring along this depth gradient. The 10-75m and 75-200m depths combined make up approximately 94% of the Northern Ireland inshore region, and 35% of this combined area is found within MPAs. Nevertheless, North Channel cSAC accounts for a substantial proportion of this coverage yet it does not currently protect seabed habitats, therefore these results are not indicative of seabed protection *per se*. The very shallow (0-10m) and very deep (>200m) depths bands occupy only a small proportion of the Northern Ireland inshore region but their coverage within MPAs is high (>70%).

This approach is rudimentary as it does not directly measure the protection afforded to the detailed and distinct biological communities present in MPAs at these depth bands. Furthermore, the variety and distribution of biological communities within the Northern Ireland inshore region will not be determined by depth alone, as factors such as light penetration (particularly the contrast between the turbid waters of the Irish Sea versus the clearer waters of the Minches), currents and salinity will also have an important influence. Nevertheless, at a

[62] OSPAR (2013). An assessment of the ecological coherence of the OSPAR network of Marine Protected Areas in 2012. Available online at: http://www.ospar.org/documents/dbase/publications/p00619/p00619_ecological_coherence_report.pdf

[63] Only the Northern Ireland MPAs included in the main assessment (listed in Section 3.3) were included in this analysis (SACs, MCZs and ASSIs). No distinction was made between sites protecting seabed habitat and those that do not (i.e. sites protecting species above the seabed only, such as North Channel cSAC). SPAs and Ramsar Sites were excluded. The substantial spatial overlaps between Ramsar Sites and other MPAs means they would add very little additional MPA coverage (and to the shallower depth bands only).

[64] EMODnet Digital Elevation Model 2015.

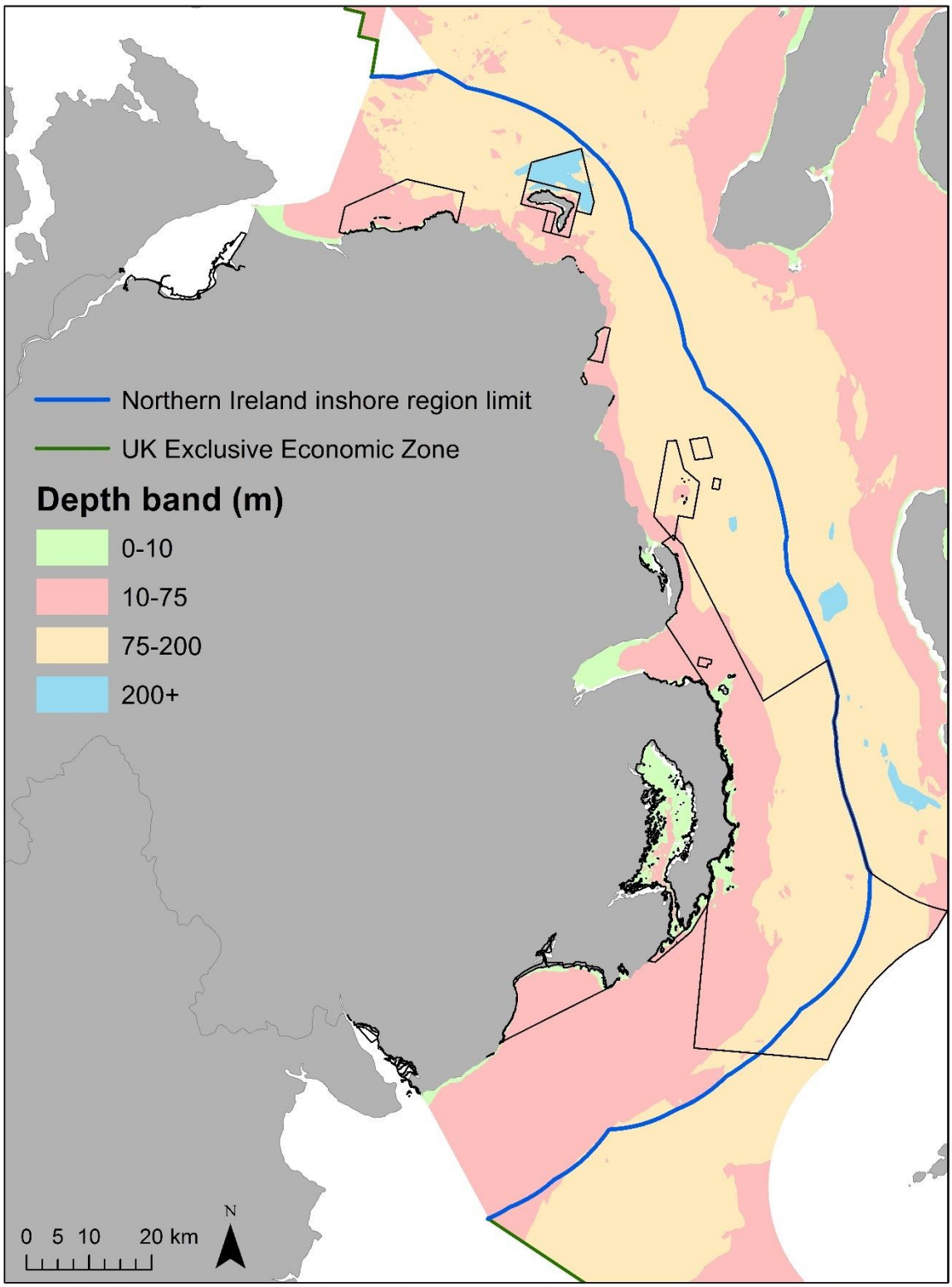


Figure AE.1. Distribution of Northern Ireland MPAs (those included in the MPA network assessment, see Section 3.3) relative to seabed depth (m) in the Northern Ireland inshore region.

coarse resolution if a broad depth band is poorly represented in MPAs it would suggest a potential gap in the ecological coherence of the network[62].

Table AE.1. The percentage area of the Northern Ireland inshore region occupied by each depth band and the percentage area of each depth zone in Northern Ireland inshore MPAs.

Depth band (m)	Percentage area of Northern Ireland inshore region (%)	Percentage area of Northern Ireland inshore region in MPAs (%)
0-10	4.8	71.7
10-75	44.8	36.3
75-200	49.3	34.2
>200	1.2	85.9

AE.2 Broad-scale habitat protection by depth biozones

The present study used the broad-scale habitats listed in Annex A as a proxy to represent the full range of more detailed habitats and species found within the Northern Ireland inshore region. However, some broad-scale habitats (particularly subtidal sediments) occur across a range of physical conditions resulting in many detailed habitats and biological communities within them in the habitat classification hierarchy (for example at EUNIS level 4 and beyond). If there is a limited number of MPAs protecting a broad-scale habitat (or a limited total extent of habitat within the MPAs), there is a reasonable likelihood that the range of biological communities known to comprise that habitat would not be protected by the MPAs.

JNCC considered the representativity and extent of broad-scale habitats within MPAs across two biological zones (biozones) to better assess whether the full range of biodiversity within broad-scale habitats in the Northern Ireland inshore region is likely to be represented in the MPA network. The broad-scale habitats adopted for the main assessment (listed in Annex A) already distinguish between intertidal and subtidal zones, so the analysis focussed on subtidal habitats which can encompass a relatively wide range of physical conditions not captured at the broad-scale habitats' coarse resolution.

The spatial limits of the shallow, shelf and deeper shelf biozones were modelled by the UKSeaMap project 2016[65] and were defined by the depth at which the seabed is no longer disturbed by wave action[66]. In the Northern Ireland inshore region this definition relates to a seabed depth of approximately 50m around the northern and eastern coasts (Figure AE.2), although this varies depending on energy levels at any given location. This layer creates a rudimentary proxy for the range of seabed habitats and associated biological communities that could occur in higher versus lower energy environments in the circalittoral zone. The limits of these biozones were included in the GIS analysis for adequacy to divide the subtidal Northern Ireland inshore region into two zones and provide a breakdown of the percentage area of each broad-scale habitat protected in each biozone. Only the Northern Ireland MPAs currently protecting subtidal broad-scale habitats were included in this analysis[67] (Figure AE.2).

[65] JNCC (2017). UKSeaMap 2016: broad-scale habitat map for UK waters. Available online at http://jncc.defra.gov.uk/ukseamap

[66] The division between shallow and shelf waters is defined by a 1.6-2.4 wave base ratio (wave length/water depth) fuzzy threshold, predicted using wave energy models and bathymetric data. For more information see the following report and technical appendixes:
Populus J. et al. (2017). EUSeaMap, a European broad-scale seabed habitat map. 174p. http://doi.org/10.13155/49975. Available online at http://www.emodnet-seabedhabitats.eu/outputs

[67] For example, North Channel cSAC (designated for Harbour porpoise *Phocoena phocoena*) was excluded as this does not currently protect broad-scale habitats.

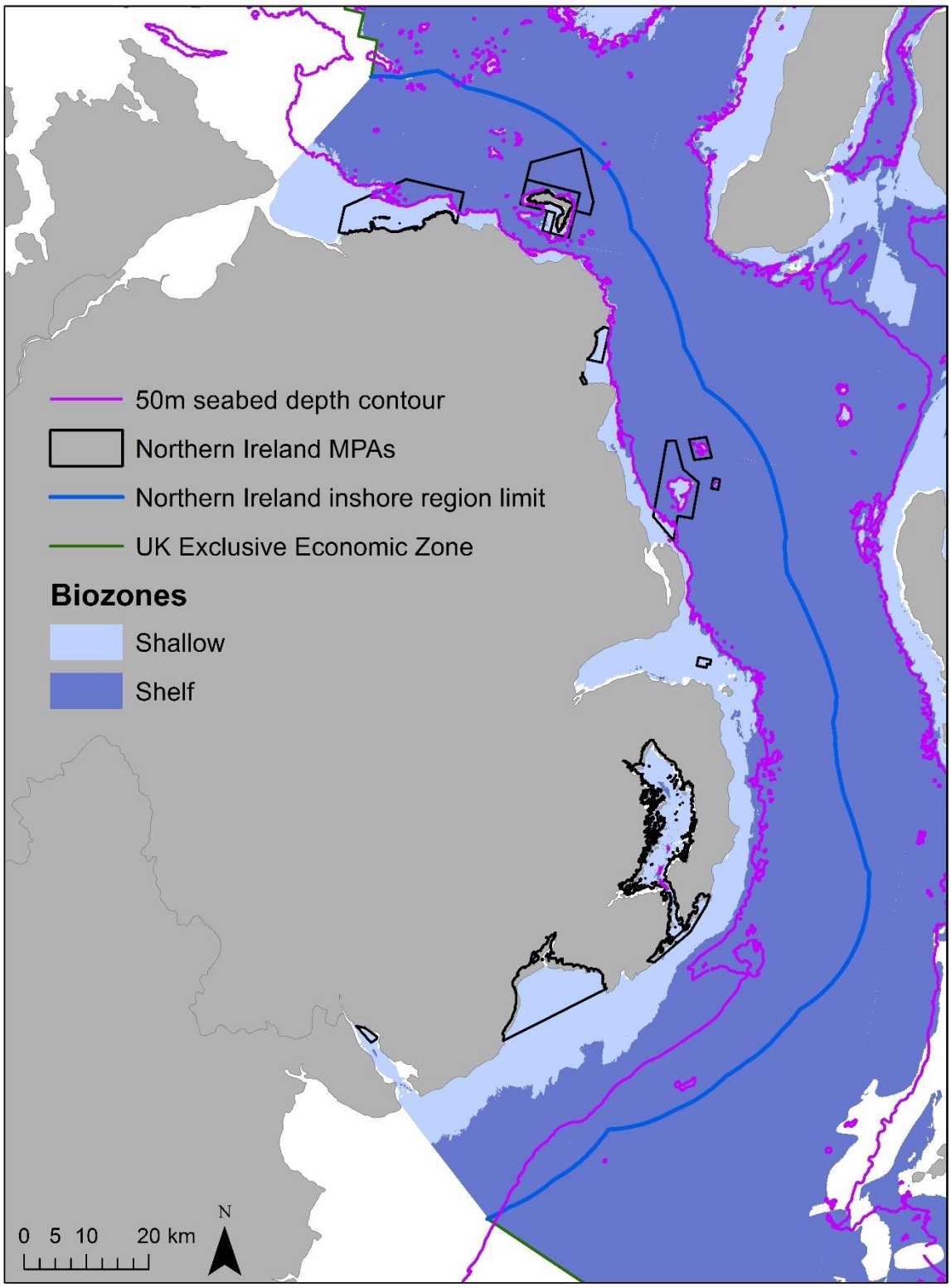


Figure AE.2. Distribution of Northern Ireland MPAs affording protection to subtidal broad-scale habitats, relative to depth biozones in the Northern Ireland inshore region. The 50m depth contour line illustrates the approximate depth at which the shallow versus shelf biozones are predicted in UKSeaMap 2016.

All twelve broad-scale habitats are represented in the shallow shelf zone of the Northern Ireland inshore region compared to nine of eleven broad-scale habitats present in the deeper shelf zone (Table AE.2). *Low energy circalittoral rock* and *Sublittoral mud* are not currently represented in Northern Ireland MPAs in the deeper shelf zone. Of the 1330km^2 of shallow, subtidal habitat found in the Northern Ireland inshore region, 17% is protected in MPAs compared to 2% of subtidal habitat protected in the 3654km^2 of the shelf zone.

Table AE.2. Representativity and adequacy of subtidal broad-scale habitats in MPAs across depth biozones in the Northern Ireland inshore region. "N/A" indicates that the habitat did not occur in the given biozone within the region.

Subtidal broad-scale habitat	Shallow shelf seabed		Deeper shelf seabed	
	Represented?	% protected (by area)	Represented?	% protected (by area)
High energy infralittoral rock	Y	55.	Y	93.4
Moderate energy infralittoral rock	Y	12.7	Y	38.3
Low energy infralittoral rock	Y	1.0	N/A	N/A
High energy circalittoral rock	Y	40.7	Y	59.4
Moderate energy circalittoral rock	Y	4.4	Y	4.1
Low energy circalittoral rock	Y	6.9	N	0.0
Sublittoral coarse sediment	Y	3.6	Y	0.1
Sublittoral sand	Y	22.8	Y	7.5
Sublittoral mud	Y	32.5	N	0.1
Sublittoral mixed sediments	Y	14.8	Y	2.2
Sublittoral macrophyte-dominated sediment	Y	42.9	Y	28.7
Sublittoral biogenic reefs	Y	100	Y	100

Eight of the twelve subtidal broad-scale habitats occurring in the shallow shelf zones of the Northern Ireland inshore region have >10% of their areas protected in MPAs (Table AE.2). Of the four habitats that have <10% of their area protected in this biozone, large areas of *Moderate energy circalittoral rock* and *Sublittoral coarse sediment* occur outside MPAs in the shallow shelf zone, suggesting the MPA network may not be representing all of their likely biological communities at this depth. The total extents of *Low energy infralittoral rock* and *Low energy circalittoral rock* in this zone are very small and the habitat outside MPAs, where it occurs, is unlikely to be viable for further protection.

In the deeper shelf zone, <10% of the areas of *Moderate energy circalittoral rock*, *Low energy circalittoral rock*, *Sublittoral coarse sediment*, *Sublittoral sand*, *Sublittoral mud* and *Sublittoral mixed sediments* are protected in MPAs. These habitats comprise >99% of the deeper shelf area of the Northern Ireland inshore region and smaller proportions of these habitats are protected in the deeper shelf than in the shallow shelf zones. This would suggest that the MPA network may not represent the full range of biological communities associated with these broad-scale habitats at this depth.

This present biozone approach has similar limitations to the analysis of MPA coverage by seabed depth (Section AE.1 above). It does not directly assess the known distribution of detailed biological communities specific to subtidal broad-scale habitats in the Northern Ireland inshore region, and depth and wave action are not the only factors that will determine the variety of communities found throughout the inshore region. However, if only a small area of a broad-scale habitat is protected in deeper relative to shallower shelf biozones, the biological communities assumed to occur in the deeper, lower-energy seabed are less likely to be as well represented as their shallower counterparts. This could indicate the network may be less ecologically coherent. If this initial test is met or if more detailed data are available then the approach could be further refined to include more complex factors such as light

penetration, currents and salinity to offer a more realistic assessment of whether the range of detailed biological communities are represented in the network.

AE.3 Site viability

Site viability for the Northern Ireland MPAs protecting broad-scale habitats was assessed using the size thresholds suggested in the MCZ Ecological Network Guidance (ENG)[68]. A minimum diameter threshold of 5km and an average diameter threshold of 10-20km were converted into an area figure for ease of calculation, assuming that such a site was circular. When converted into an area, the 5km minimum diameter becomes a minimum target area of 19.6km^2 per site (using $\pi r^2 = \pi \times 2.5^2$). Figure AE.3 demonstrates how this minimum threshold area was compared at a site-by-site level. The average 10-20km diameter threshold was assessed by comparing the mean area of existing MPAs to an average area target of 65.1km^2.

ASSIs were discounted from this analysis, as they positively skewed the average area due to their intertidal and size-restricted nature. Viability of MPAs across the rest of the biogeographic regions was also assessed to provide a comparison with the viability of the Northern Ireland MPA network; this wider analysis included SACs, MCZs, NCMPAs and a subset of Ramsar Sites from England, Wales and Scotland combined.

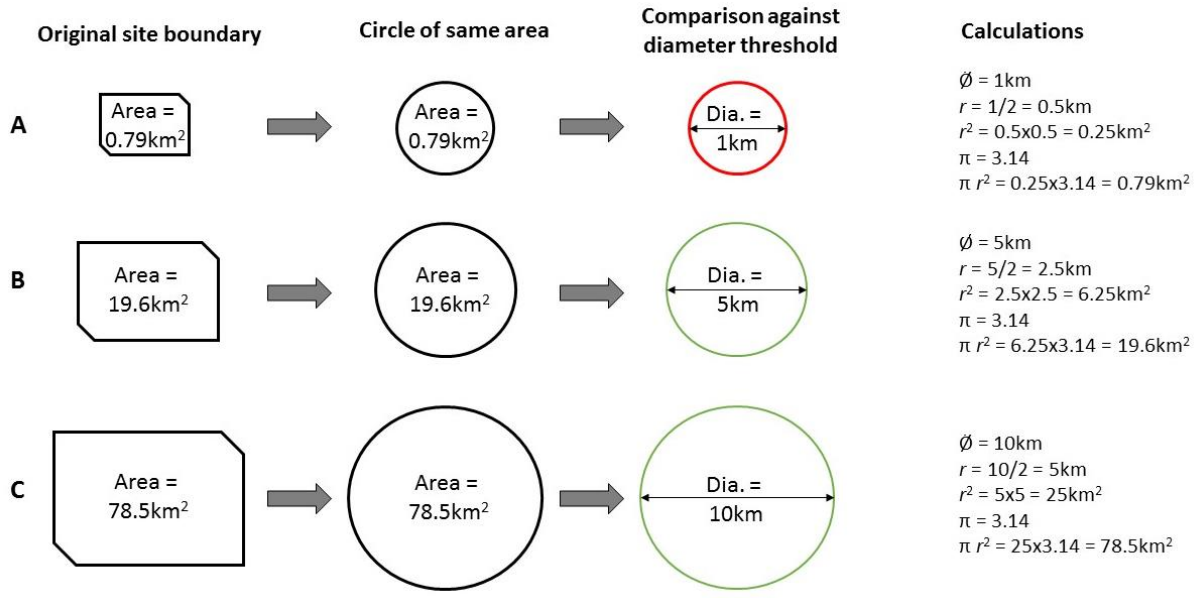


Figure AE.3. Concept diagram demonstrating site viability assessment method. Sites were assumed to be circular in shape, enabling their area (based on the original shape of the site) to be crudely compared to the area calculated from the diameter threshold of 5km. In this example, site A (red circle) did not meet the minimum target area derived from the minimum diameter threshold, whereas sites B and C (green circles) met and exceeded the target area respectively.

In the Northern Ireland inshore region, 67% of MPAs protecting broad-scale habitats meet or exceed the minimum area threshold suggesting these MPAs hold viable areas of their protected features. This result compares favourably with the size of MPAs across the rest of the wider biogeographic regions (including English, Welsh and Scottish MPAs), with 75% of MPAs in rest of the Irish Sea region and 61% of MPAs in the rest of the Minches & Western

[68] Natural England and the Joint Nature Conservation Committee (2010). *The Marine Conservation Zone Ecological Network Guidance*. Sheffield and Peterborough, UK. Available at: http://jncc.defra.gov.uk/pdf/100705_ENG_v10.pdf

Scotland region meeting or exceeding this minimum area. Furthermore, 50% of Northern Ireland MPAs meet or exceed the average size target (based on a 10-20km diameter threshold).

Document Version Control

Version	Created by	Changes made	Issued to	Date
6.0	Alice Cornthwaite & Hugh Wright, JNCC	Addressed comments from the MPA sub group	DAERA	17/01/2018
5.0	Alice Cornthwaite & Hugh Wright, JNCC	Addressed further comments provided by DAERA	MPA sub group	22/09/2017
4.0	Alice Cornthwaite & Hugh Wright, JNCC	Addressed comments provided by Jon Davies and DAERA	DAERA	15/09/2017
3.0	Alice Cornthwaite, Bekah Cioffi & Hugh Wright, JNCC	Addressed comments provided by DAERA	Jon Davies, JNCC	31/08/2017
2.0	Colin Armstrong, Clara Alonso Alvarez, Nuala McQuaid, Joe Breen, Carol O'Boyle, DAERA	Commented on first complete draft	JNCC	25/08/2017
1.0	Alice Cornthwaite, Bekah Cioffi & Hugh Wright, JNCC	First complete draft	DAERA	16/08/2017